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Feasibility Report and Final Environmental Impact Statement/Report
Water Resources Investigation

Saugus River and Tributaries, Lynn, Malden, Revere and
Saugus, Massachusetts

Flood Damage Reduction

Main Report - Section 2 (Final Environmental Impact Statement/Report)

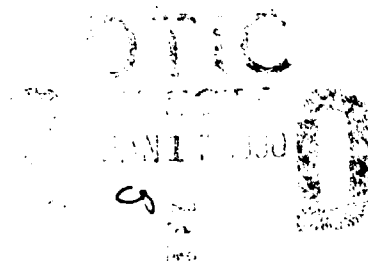
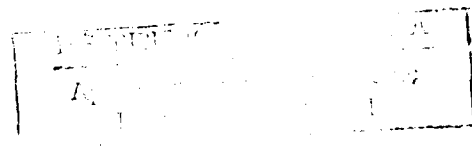
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<p>This report summarizes the coastal flooding problems in the Saugus River and tributaries area and the possible alternative solutions; this volume identifies environmental resources in the study area and the potential impacts of alternative solutions as required by the Federal (NEPA) and state (MEPA) environmental processes.</p> <p style="text-align: right;">Continued</p>					
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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

WATER RESOURCES INVESTIGATION
FEASIBILITY REPORT
FINAL ENVIRONMENTAL IMPACT STATEMENT
AND
FINAL ENVIRONMENTAL IMPACT REPORT
(EOEA FILE NUMBER 6497)

SAUGUS RIVER AND TRIBUTARIES
FLOOD DAMAGE REDUCTION STUDY

LYNN, MALDEN, REVERE
AND SAUGUS, MASSACHUSETTS

Section 2

FINAL ENVIRONMENTAL IMPACT STATEMENT
AND
FINAL ENVIRONMENTAL IMPACT REPORT



December 1989

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SAUGUS RIVER AND TRIBUTARIES FLOOD DAMAGE REDUCTION STUDY

Lynn, Malden, Revere and Saugus, Massachusetts/Summary of Study Reports:

Main Report and Environmental Impact Statement/Report (EIS/EIR): Summarizes the coastal flooding problems in the study area and alternative solutions; describes the selected plan and implementation responsibilities of the selected plan; and identifies environmental resources in the study area and potential impacts of alternative solutions, as required by the Federal (NEPA) and state (MEPA) environmental processes.

Plan Formulation (Appendix A): Provides detailed information on the coastal flooding problem and the alternatives investigated; includes: sensitivity analyses on floodgate selection (including location and size of gates and sea level rise); optimization of plans; comparison of alternative measures to reduce impacts; and public concerns.

Hydrology and Hydraulics (Appendix B): Includes descriptions of: the tidal hydrology and hydrology of interior runoff in the study area, and of wave runoff and seawall overtopping, interior flood stage frequencies, tide levels, flushing, currents, and sea level rise effects without and with the selected project for various gated openings.

Water Quality (Appendix C): Includes descriptions of existing water quality conditions in the estuary and explores potential changes associated with the selected plan.

Design and Costs (Appendix D): Includes detailed descriptions, plans and profiles and design considerations of the selected plan; coastal analysis of the shorefront; detailed project costs; scope and costs of engineering and design; scope and costs of operation and maintenance; and design and construction schedules.

Geotechnical (Appendix E): Describes geotechnical and foundation conditions in the study area and the design of earth embankment structures in the selected plan.

Real Estate (Appendix F): Describes lands and damages, temporary and permanent easements and costs of the selected plan, including the five floodgate alignments studied.

Economics (Appendix G): Describes recurring and average annual damages and benefits in study area floodzones; economic analysis and optimization of alternative plans.

Socioeconomic (Appendix H): Describes the socioeconomic conditions in the study area and the affects of the selected plan on development in the floodplain and estuary.

Planning Correspondence (Appendix I): Includes all letters between community officials, agencies, organizations and the public and the Corps prior to agency and public review of the draft report.

Feasibility Study and EIS/EIR Comments and Responses (Appendix J): Includes all project revisions, and comments and Corps responses to letters received during agency and public review.

Environmental (Appendix K): Includes basic data from investigations of environmental resources in the study area and presents the Mitigation Incremental Analysis.

FINAL
ENVIRONMENTAL IMPACT STATEMENT
AND
ENVIRONMENTAL IMPACT REPORT

Proposed Plan for Flood Damage Reduction - Saugus River
and Tributaries - Lynn, Malden, Revere and Saugus, Massachusetts

The responsible lead agency is the New England Division, U.S. Army Corps of Engineers, Waltham, Massachusetts.

Abstract: This document is intended to serve both the National Environmental Policy Act (NEPA) and Massachusetts Environmental Policy Act (MEPA) reporting requirements. NEPA requires an Environmental Impact Statement (EIS); MEPA requires an Environmental Impact Report (EIR). The MEPA proponents are the communities of Lynn, Malden, Revere and Saugus and the Massachusetts Metropolitan District Commission (MDC).

The New England Division has investigated public concerns related to the need for tidal flood damage reduction in four communities along the northeastern coast of Massachusetts: Lynn, Malden, Revere, and Saugus. The communities surround a 1660 acre saltwater estuary at the confluence of the Saugus and Pines Rivers. The coastal shorefront in the Study Area is in Revere and Lynn. Three basic options were evaluated during the study and are discussed in detail in this document. Option 1 - Four Structural Local Protection Plans (LPPs), consisting of 8.8 miles of shore-front structures would reduce flood damages to 3,950 buildings in the areas of Revere Beach Backshore, Town Line Brook, East Saugus and Lynn and reduce flooding of the MBTA Blue Line and Route 1A, as well as on local streets behind the LPP structures. 17.7 acres of vegetated wetlands and 14.6 acres of intertidal habitat would be lost. Option 2 - Nonstructural Plans would reduce the vulnerability to flooding through flood preparedness plans and floodproofing of about 240 individual structures, about 7% of the structures in the Standard Project Northeast (SPN) floodplain. No significant impacts would be anticipated. Option 3 - The Regional Saugus River Floodgate Plan consists of a floodgate structure across the mouth of the Saugus River and shorefront protection along Revere Beach, Point of Pines and Lynn Harbor for a total of 3.5 miles of structures. Two (2.0) acres of intertidal and 1.0 acre of subtidal habitat would be lost. No vegetated wetlands would be lost. The plan requires acquisition in fee or easement of about 1660 acres of estuary storage area. Protection of the estuarine area also includes an environment enforcement manager, mapping the wetlands boundary, and starting a community awareness program. This plan would reduce flooding throughout the entire Study Area, including 5,000 buildings, all major transportation arteries serving the Study Area and Boston's north shore, and local streets inside the floodgates and behind shorefront structures. Mitigation proposals are presented for both Option 1 and Option 3. Option 3 is the preferred option based on its performance in addressing the identified public concerns and its net positive contributions to the goal of National Economic Development.

SEND YOUR COMMENTS TO THE DIVISION ENGINEER, WITH A COPY TO THE MASSACHUSETTS MEPA OFFICE, BY THE DATE INDICATED IN THE TRANSMITTAL LETTER. THE ADDRESSES FOLLOW:

Colonel Daniel M. Wilson, Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02254-9149

Mr. David Shepardson
EOEA/MEPA Unit
100 Cambridge Street, 20th Floor
Boston, Massachusetts 02202
Reference: EOEA File Number 6497
Telephone 617-727-5830

If you would like further information on this document, please contact:

Mr. William A. Hubbard and Mr. Lawrence R. Oliver, EIS/EIR Managers
U.S. Army Engineer Division, New England (CENED-PL-I)
424 Trapelo Road
Waltham, Massachusetts 02254-9149
Telephone 617-647-8236

NOTE: Information, displays, etc. discussed in the Main Report, including all Appendices thereto, are incorporated by reference into the Final EIS/EIR.

The Appendices are available upon request or may be reviewed at the libraries or planning offices in Lynn, Revere and Saugus, or at the Corps of Engineers Library by contacting Mr. Tim Hays at 617-647-8118. Those most pertinent to the EIS/EIR are noted by an asterisk (*).

The Appendices are:

- *A - Plan Formulation
- *B - Hydrology and Hydraulics
- *C - Water Quality
- D - Design and Costs
- E - Geotechnical
- F - Real Estate
- G - Economics
- *H - Socioeconomic
- *I - Planning Correspondence
- *J - Project Revisions and Comments and Responses
- *K - Environmental

A short description of each of the Appendices may be found immediately following the Main Report Table of Contents.

Table 1 - FEIS/FEIR
Document Revisions Following Draft Review

EIS-1 Abstract revised to include project changes

EIS-2 EIS/EIR managers changed

Paragraphs:

2.04 Regional Plan changes
2.05 Editorial
2.17 Editorial
2.21 through 2.25 Summary of major concerns/revisions
5.04 Changes to Option 1
5.06 Wetlands protection features contrasted.
5.14 Editorial
5.18 Editorial
5.19 Editorial
5.20 Updated costs
5.23 Editorial
5.26 Reduction in impacts associated with Lynn Harbor
5.28 Editorial
5.30 Editorial
5.38 Reduction in Lynn Harbor impacts
5.39 Reduction in Lynn Harbor impacts
5.40 Deleted
5.41 Editorial
5.45 Editorial
5.48 Editorial
5.50 Editorial
5.56 Option 1 - Inclusion of monitoring at 2 and 4 years
5.57 Option 1 reduction in Lynn harbor impacts
5.58 Editorial
5.59 Editorial
5.64 Editorial and inclusion of estuary acquisition
5.65 Clarification of gate closures at 100 years project life as well as recent project cost figures
5.66 through 5.77 Reduction in impact/mitigation acres and discussions of changes in project features associated with Option 3
5.80 Editorial
5.81 Editorial
5.82 Editorial
5.83 Editorial
6.02 Discussion of future without project efforts to raise river banks against Sea Level Rise
6.06 Expansion of discussion of ACEC
6.14 Expansion of Seal Level Rise discussion
6.15 Discussion of ACEC vs. water quality
6.31 Inclusion of chromium

Table i (Continued)

6.35 Inclusion of sea level rise
 6.36 Editorial
 6.54 Editorial
 6.55 Editorial
 6.61 Editorial
 6.65 Editorial
 6.68 Editorial
 6.91 Editorial
 6.116A Discussion of ACEC
 6.142 Editorial
 7.02 Deletion of reference to open gate constrictions.
 7.04 Inclusion of sea level rise increased closures to 40 times per year
 7.11 Editorial
 7.20 Editorial
 7.22 Editorial
 7.32 Expansion of discussion on detrital export with storms
 7.33 Editorial
 7.36 Revised impact discussion to Lynn
 7.39 Revised impact discussion to Lynn
 7.40 Editorial
 7.1 Table - lowered impact numbers
 7.44 Editorial
 7.45 Editorial
 7.46 Editorial
 7.48 Lowered impact acreage to Lynn Harbor
 7.2 Table Lowered impact acreage to Lynn Harbor
 7.50 Lowered impact acreage to Lynn Harbor
 7.60 Editorial
 7.82 Editorial
 7.84 Explanation of gate sizing
 7.85 Editorial
 7.90 Editorial
 7.91 Lowering of impact acreage
 7.98 Increase of impact acreage from 1.6 to 2 acres
 7.99 Increase at subtidal loss from 0.6 to 1.0 acres
 7.106 Editorial
 7.108 Lowering of impact acreage
 7.111 Lowering of impact acreage
 7.113 Lowering of impact acreage
 7.117 Discussion of mussel bed impact
 7.123 Inclusion of the ACEC standards
 7.125 Inclusion of marsh acquisition, wetlands restriction, etc.
 7.127 Inclusion of marsh acquisition and environmental manager
 7.129 Manager deleted
 7.130 Deleted
 7.135 Editorial
 7.145 Decrease truck trips number
 7.146 Increase truck trips number
 7.173 Editorial

Table i (Continued)

7.195 Editorial
7.196 Replaced landscaping discussion
8.34 to 8.39 Expanded sea level rise discussion
10.16 Expanded discussion of Post-DEIS discussion
10.18 Expanded discussion of Post-DEIS discussion
10.19 Expanded discussion of Post-DEIS discussion
10.24 Expanded discussion of Post-DEIS discussion
10.25 Expanded discussion of Post-DEIS discussion
10.26 Expanded discussion of Post-DEIS discussion
Pg. EIS-167 Reduced impacts
Pg. EIS-176 Reduced impacts to Option 3
404(b)1 Evaluation - incorporated project changes

2.0 Summary

A. Major Conclusions and Findings

2.01 Three basic options for reducing damages due to tidal flooding in the communities of Lynn, Malden, Revere and Saugus, MA were investigated, plus the No Action Alternative.

2.02 Option 1. Four Structural Local Protection Plans (LPPs) - This option would reduce flood damages to 3,950 buildings in the Revere Beach Backshore, Town Line Brook, East Saugus and Lynn areas and reduce flooding of the MBTA Blue Line and Route 1A, as well as on local streets behind the LPP structures. About 8.8 miles of dikes and walls would be constructed along the edge of the estuarine wetland and the banks of the Saugus and Pines Rivers as well as along parts of the Revere Beach and Lynn Harbor shorefronts. 17.7 acres of vegetated wetlands and 14.6 acres of intertidal habitat would be lost.

2.03 Option 2. Nonstructural Plans - This option would reduce the vulnerability to flooding through flood preparedness plans and floodproofing of about 240 buildings, about 7% of the structures in the Standard Project Northeast (SPN) floodplain. An alternative plan to floodproof all buildings is evaluated in Appendix J. However, it has a very low probability of being implementable due to lack of economic feasibility and uncertainty in providing adequate warning and evacuation times. As a result, public safety cannot be assured.

2.04 Option 3. Regional Saugus River Floodgate Plan - This plan, with a total of 3.5 miles of structures would reduce flooding throughout the entire Study Area (5,000 buildings plus all major transportation arteries serving the Study Area and Boston's north shore and local streets inside the floodgates and behind shorefront structures). A floodgate structure would be located at the mouth of the Saugus River, about 700 feet downstream of the General Edwards Bridge. Navigation and flushing gates would maintain both safe navigation and the natural flushing of the rivers and wetlands by remaining open until the threat of a flood. During storm tide conditions the gates would be closed for a few hours during high tide. Closure would occur two to three times a year, when tides are projected to reach about El.8 feet NGVD, the level at which significant damages begin around the estuary. Dikes and walls would reduce wave overtopping along the Revere Beach, Lynn Harbor and Point of Pines shorefronts and reduce flooding throughout the study area. Disposal of approximately 114,200 cubic yards of dredged material would be at the Massachusetts Bay Disposal Site. Two (2.0) acres of intertidal habitat and 1.0 acre of subtidal habitat would be lost. No vegetated wetlands would be lost. The plan requires acquisition (in fee or easement) of about 1660 acres of estuarine flood storage area for runoff and tidal overtopping. Additional protection would be afforded through appointment of a full time environmental enforcement manager to monitor and enforce acquisition limits of the storage area, and existing regulations, and creation of a Public Awareness Program.

2.04A Option 1 wetland and intertidal losses and Option 3 intertidal and subtidal losses would be fully mitigated.

2.05 The National Economic Development (NED) plan, and the preferred alternative is Option 3 as it is the most desirable from an engineering, economic, and social standpoint and more acceptable from an environmental standpoint than Option 1. It also produced the highest net economic benefits and minimizes unmitigatable environmental impacts in the estuary. The Regional Floodgate Plan provides the highest degree of flood protection and is strongly supported by the study sponsors: the Massachusetts Metropolitan District Commission (MDC), the cities of Lynn, Malden and Revere and the town of Saugus. The plan meets the formulation criteria set forth in Principles and Guidelines (P&G) of being complete, effective, efficient and acceptable and meets the study objectives outlined in the Main Report and in Chapter 4D of this EIS/EIR.

2.05A A summary table of comparative impacts of the three project options and the No Action Alternative is provided at the end of Chapter 5. Chapter 6 discusses the affected environment in detail. Chapter 7 analyzes the environmental effects of the alternatives in detail. A Study Area map is provided at the beginning of Chapter 6 (Figure 6.1).

B. Other Conclusions and Findings

Clean Water Act of 1977

2.06 A Section 404 (b)(1) Evaluation has been incorporated into this document. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) Guidelines. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.

Executive Order 11988 - Floodplain Management

2.07 Option 3 is consistent with the intent of Executive Order 11988. The plan minimizes potential harm to or within the floodplain.

Executive Order 11990 - Protection of Wetlands

2.08 Impacts are considered to be consistent with the Executive Order's intent to minimize the destruction, loss and degradation of wetlands. No induced development in wetlands would be promoted by the proposed project. The necessary loss of intertidal habitat would be mitigated.

Coastal Zone Management Act of 1972

2.09 The proposed project is consistent to the maximum extent practicable with the approved Massachusetts Coastal Zone Management Program. A Consistency Determination shall be provided to the State for review and concurrence.

Marine Protection Research and Sanctuaries Act

2.10 Dredged material would be taken for disposal to the Massachusetts Bay Disposal Site, approximately 15 nautical miles east of Lynn Harbor. The material will be reviewed by the Corps under the provisions of this Act, including appropriate testing, during the project design phase.

National Historic Preservation Act of 1966

2.11 The proposed project has been inspected by the State Historic Preservation Office (SHPO). The proposed Regional Saugus River Floodgate Plan would have no impacts on historic properties. The Main Report and EIS will supply the SHPO with the detailed information necessary for them to provide official concurrence with NED's determination of no effect for the Regional Plan.

Endangered Species Act of 1973, as amended

2.12 Coordination with the U.S. Fish and Wildlife Service and NOAA-Fisheries has yielded no formal consultation requirements pursuant to Section 7 of the Act.

Estuary Protection Act

2.13 This document will be made available to the Department of the Interior for review and comment when the project report/EIS are circulated for departmental review.

Fish and Wildlife Coordination Act

2.14 Coordination has been carried out with the U.S. Fish and Wildlife Service, NOAA-Fisheries and appropriate State fish and wildlife agencies. Full consideration has been given to comments and views expressed by these agencies in evaluating the proposed project, as well as to fish and wildlife conservation.

National Environmental Policy Act (NEPA)

2.15 This document has been prepared under the NEPA guidelines. Full compliance under NEPA will be noted at the time the Final EIS and Record of Decision are released.

Clean Air Act, as amended

2.16 This document will be made available to the Regional Administrator of the Environmental Protection Agency for review pursuant to Sections 176c and 309 of the Act.

Commonwealth of Massachusetts Statutes

2.17 This document serves as a Final Environmental Impact Report (EIR) pursuant to the Massachusetts Environmental Policy Act (MEPA). The Scope of the EIR effort as directed by the MEPA Office may be found in Chapter 11 of this document. The EIR will be reviewed in accordance with MEPA Regulations. Subsequent to approval of the Final EIR, application will be made by the project proponents for appropriate State permits (see Chapter 11).

C. Areas of Concern

2.18 Four areas of greatest concern were followed during the coordination of this study and the development of this document.

2.19 The first area of concern is the desire that minimal or no losses of vegetated wetlands take place by virtue of project construction. Under Option 3, the Regional Plan, no vegetated wetlands would be lost. Option 2 would, by definition as nonstructural, cause no vegetated wetland losses. Under Option 1, 17.7 acres of vegetated wetlands would be lost.

2.20 The second area of concern is the desire that minimal or no impact on the dynamics of the estuarine ecosystem and navigational safety take place by virtue of construction and operation of Option 3's floodgate structure at the mouth of the Saugus River. The floodgate structure and its proposed operational mode have been specifically designed for no significant adverse impact on the dynamics of the estuary and navigational safety. This is supported by the environmental analyses contained within this document.

2.21 The third area of concern is that the construction of flood protective structures would cause induced land development pressures within the estuary. This concern led to an extensive study of the question by IEP, Incorporated of Northborough, Massachusetts, under contract to the Corps. IEP studied such factors, both with and without the proposed project options, as historical and existing land use (including wetland filling), developable land available, plans for development, pressures for development and barriers to development (including economic, regulatory, topographic and other factors). IEP concluded that without the proposed project, development will continue within the floodplain as long as it is economical and the land is available. Development within the marsh is precluded by regulation, although illegal filling continues to some degree. The proposed project options would not change the controlling factors outside of the marsh, which appear to be land availability and the general economic climate, and would not change the regulatory protection of the marsh itself. Therefore, it was concluded that the protection afforded against flooding by the project options would not lead to any induced development within the marsh or the floodplain. In fact, acquisition of about 1660 acres of estuarine storage area and increased monitoring and enforcement of existing regulations, including

education of all pertinent interests, would be required of the project sponsors, with support of the Federal agencies, to assure protection of the natural estuarine flood storage area under Option 3, the Regional Plan. Additional protection measures include provisions for a full time environmental enforcement manager, mapping of wetland and acquisition boundaries, and a public awareness program.

2.22 During the draft review of this report, comments received from Federal and State agencies and interest groups strongly opposed the loss of intertidal sand flats in Lynn Harbor. The Corps met with representatives of the South Harbor developer, State Coastal Zone Management Office, Lynn Planning Office and Washington Level Review personnel. Discussions and analysis led to revised recommendation for dikes to be built inland of the toe of the bulkhead or shorefront which would eliminate the loss. This location is dependent on the developer obtaining a State approved plan (similar to that shown in the main report) prior to Corps final design. An approved plan would lower the real estate value of the shorefront. Without an approved plan, a wall or dike could be built 300 feet inland along the back property boundary. Other inland options are also available to the developer, for example, raising the ground level of the area at or above about EL. 15 with a lower dike along the shore.

2.23 Federal and State agencies also required additional nonstructural analysis. The MA Dept. of Environmental Management (DEM) requested an analysis to provide 100 percent protection to all properties and safety to residents. The analysis in Appendix J shows the cost of such a plan exceeds \$100 million and is not economically feasible. Most important, there is no way to assure the safe evacuation of residents prior to a northeaster coastal storm. The state-of-the-art for coastal flood warning necessary to assure community-wide evacuation is not sufficient to accurately predict the severity of pending flooding. Therefore, the plan does not meet Federal criteria for recommendation since it is not economically feasible, nor effective in assuring safe evacuation for public safety.

2.24 Another major concern of agencies and interest groups was the need for a more definitive plan for accelerated sea level rise. They realized the potential impact rising sea level could have on the estuary from increase operations of the floodgate which would significantly exceed 40 times per year. Therefore, the plan also recommends a future investigation if accelerated sea level rise occurs to determine modification to the project which may be necessary as sea level rise reaches one foot, unless policy decision dictate abandoning the coastal floodplain. The results of modifications may require limiting the number of gate closures between three and 40 per year which could be accomplished by construction upland of one foot high walls or dikes around the estuary for each foot of sea level rise. The cost would likely be offset by eliminating the floodgates increased operation and maintenance costs of more frequent closures. Modifications may also include raising structures along the ocean

shorefront to return level of protection back to SPN as it approaches a 350 year level with a one foot rise in sea level. If policy decisions have been made to abandon its coastal floodplains, the project is economically justified for a 35 year life, the point at which a one foot rise could occur under the worst case (Case III) of sea level rise.

D. Unresolved Issues

2.25 Concern for potential impacts on finfish and plankton passing through the submerged opening in the tainter gates was expressed. Finfish which swim in the top 12 feet (and most concentrated within two to six feet) of the water surface would encounter an obstruction above the gates within two to five feet of the water surface during high tide. The fish can swim through either the 14 foot high opening in the tainter gates, or through the unrestricted opening of the 100 foot wide navigation gate except during the brief closure period. The impact on fish passage is difficult to quantify, but based on our research, it is the conclusion of the EIS that juvenile and adult fish will traverse the floodgates without a significant impact.

The gate openings may be raised a few feet in final design, if necessary, to improve flow. Additionally, rounded corners on the gate openings and the 50 to 100 foot wide gates used would reduce any potential impingement of plankton and larval finfish passing through the gate openings.

3.0 TABLE OF CONTENTS

		<u>Page</u>
1.0	<u>Cover Sheet</u> (including Abstract)	1
2.0	<u>Summary</u>	3
A	Major Conclusions and Findings	3
B	Other Conclusions and Findings	4
C	Areas of Concern	6
D	Unresolved Issues	7
3.0	<u>Table of Contents</u>	8
	<u>List of Tables</u>	12
	<u>List of Figures</u>	12
4.0	<u>Need for and Objectives of Action</u>	13
A	Study Authority and Background	13
B	Public Concerns	14
C	Problems and Opportunities	14
D	Planning Objectives	15
5.0	<u>Alternatives</u>	17
A	Plans Eliminated from Further Study	17
B	Without Conditions (No Action)	18
C	Plans Considered in Detail (including Mitigation)	21
D	Comparative Impacts of Alternatives	36
6.0	<u>Affected Environment</u>	43
A	Introduction	43
B	Hydrology and Hydraulics	45
	Astronomic Tide Levels	45
	Storm Tides	47
C	Water Quality	48
	General	48
	Major Pollution Sources	49
	Water Quality Parameters	49
	Contaminants	51
D	Estuarine and Coastal Resources - Introduction	52
E	Wetlands	52
	General	52
	Salt Marsh	53
	Tidal Freshwater/Brackish Marsh	54
	Description of Community Types	55
F	Benthic Habitats	61

G	Sandy Beaches	66
H	Artificial Shorelines	68
I	Fish	70
J	Lobsters	75
K	Wildlife	78
	Marine Mammals	78
	Mammals, Reptiles and Amphibians	78
	Birds	79
L	Rare, Threatened and Endangered Species	84
M	Social and Economic Factors - Introduction	84
N	Land Use	84
	Communities	85
	Within the SPN Floodplain	87
O	Property Values and Housing	90
P	Business and Industrial Activity and	91
	Regional Growth	
	Commercial Fishing and Commercial Fishing	91
	Fleet	
Q	Employment	92
R	Population and Community Growth, Including	92
	Displacement	
S	Public Facilities and Services	92
T	Transportation	93
U	Navigation	94
V	Recreation and Open Space	94
W	Noise	96
X	Air Quality	96
Y	Visual Resources	97
Z	Historic and Archaeological Resources	98
7.0	<u>Environmental Effects of Detailed Plans</u>	102
A	Introduction	102
B	Hydrology and Hydraulics	102
	Tidal	102
	Flooding	104
	Flood Frequencies	104
C	Water Quality	105
D	Estuarine and Coastal Resources - Introduction	105
E	Wetlands	106
F	Benthic Habitats	109
G	Sandy Beaches	114
H	Artificial Shorelines	114
I	Fish	116
J	Lobsters	121
K	Wildlife	122
L	Rare, Threatened and Endangered Species	125
M	Social and Economic Factors - Introduction	125
N	Land Use	126
O	Property Values and Housing	127

P	Business and Industrial Activity	128
Q	Employment	128
R	Population and Community Growth, Including Displacement	128
S	Public Facilities and Services	129
T	Transportation	129
U	Navigation	130
V	Recreation and Open Space	133
W	Noise	134
X	Air Quality	135
Y	Visual Resources	136
Z	Historic and Archaeological Resources	139
AA	Secondary and Cumulative Impacts	140
8.0	<u>Sea Level Rise</u>	141
A	Historic Rise	141
B	Future Sea Level Rise	141
C	General Corps Policy Regarding Sea Level Rise	141
D	Effects of Rising Sea Level on Future Tidal Flood Frequency	142
E	Effects of Future Sea Level Rise on Tidal Floodplain Zones	142
F	Effects of Rising Sea Level on Tide Ranges and Currents	143
G	Effects of Rising Sea Level on Waves	144
H	Effects on Rising Sea Level on the Coastal Zone	144
I	Effects of Rising Sea Level on Tidal Wetlands	146
J	Effects of Rising Sea Level on Water Quality	148
K	Effects of Rising Sea Level with Flood Protection Measures	148
	Option 1	148
	Option 2	149
	Option 3	149
L	Summary and Conclusion	152
9.0	<u>List of Preparers</u>	153
10.0	<u>Public Involvement, Review and Consultation</u>	156
A	Public Involvement Program	156
B	Required Coordination	159
C	Recipients of Draft Study Report and EIS/EIR	159
D	Public Views and Responses	163
11.0	<u>Relationship to Environmental Protection Statutes and Other Environmental Requirements</u>	165
A	Compliance with Environmental Federal Statutes and Executive Orders	165

B	Compliance with State Laws and Policies	168
	MEPA	168
	Wetlands Protection Act	169
	Waterways Licensing Program (Chapter 91)	174
	Area of Critical Environmental Concern	174
12.0	<u>Index, References and Appendices</u>	176
13.0	<u>Bibliography</u>	179
	<u>Section 404(b)(1) Evaluation</u>	

LIST OF TABLES

	<u>Page*</u>
5.1 Comparative Impacts of Alternatives	37
6.1 Tidal Datum Planes	46
6.2 Annual Maximum Storm Surge	FP 47
6.3 Wetland Community Types Delineated Within the Study Area	56
6.4 Acreages of Cover Types	FP 57
6.5 Summary of Percent Frequency of Occurrence of Species Present in the Project Area Salt Marsh Transects	FP 57
6.6 Summary of Percent Frequency of Occurrence of Species Present in the Upper Saugus River and Shute Brook Transects	FP 57
6.7 Numerically Dominant Macrobenthic Taxa Collected at Subtidal Stations	FP 62
6.8 Soft Shell Clam Densities in the Study Area	65
6.9 Fishes Recorded from the Saugus/Pines Rivers Estuary and Lynn Harbor	73
6.10 Summary of Lobsters Caught in Otter Trawls and Lobster Traps	77
7.1 Summary of Benthic Habitat Impacts	111
7.2 Benthic Habitat Displaced by Footprint of Option 3	113
8.1 Future Frequency of Tidal Flooding	142
8.2 Future Sea Level Condition Boston Stillwater Elevation Frequencies	143
8.3 Change in Tidal Prism	144
8.4 Natural Beach Response to Rising Sea Level	145
8.5 Floodgate Closures with Sea Level Rise	150
10.1 Formal Coordination Activities	157
10.2 List of Recipients of Study Report and Draft EIS/EIR	160
11.1 Massachusetts Wetlands Protection Act	170

LIST OF FIGURES

5.1 Option 1 - Four Local Protection Plans	FP 22
5.2 Option 3 - Regional Saugus River Floodgate Plan	FP 30
6.1 Study Area Map	FP 43
6.2 Frequency of Tidal Flooding	FP 47
6.3 Benthos Sampling Locations	FP 62
6.4 Shellfish Sampling Locations	FP 62
8.1 Plausible Sea Level Rise from NRC	FP 141
10.1 Joint MEPA/NEPA Process	FP 156

* FP means Following Page

4.0 Need for and Objectives of Action

A. Study Authority and Background

4.01 The study was authorized by a resolution adopted 12 September 1969 by the Committee on Public Works of the United States Senate which provided for a study to determine "... the feasibility of providing water resource improvements for flood control, navigation and related purposes in Southeastern New England..."

4.02 The Southeastern New England (SENE) Study is an investigation into the water resources needs of the region. Flooding problems along the Massachusetts coast was one problem identified even before the devastating Blizzard of 1978 tidal surge hit New England. Shortly following the 1978 flood, the city of Revere requested the Corps of Engineers to investigate their flooding problem and determine solutions. A few years later the town of Saugus requested similar help, followed in 1985 by the cities of Lynn and Malden.

4.02A The flood-affected areas are adjacent to the Saugus and Pines Rivers Estuary, as well as the coastal shorefronts in Lynn and Revere. The Saugus/Pines Estuary comprises approximately 1,660 acres, of which about 1,070 acres are vegetated wetlands. Surrounding the estuary and along the Lynn and Revere shorefronts are a mixture of residential, commercial and industrial land uses.

4.02B Flooding problems in the Study Area result when the Saugus River and its tributaries convey tidal surges into the communities of Lynn, Malden, Revere and Saugus causing tide water to overflow riverbanks and flood low lying areas bordering marshland. Problems also result from tides overtopping seawalls along the shorefront of Revere and Lynn. High tides also cause local drainage systems to back up, flooding basements and streets in higher areas.

4.02C The Study Area is divided into eight flood prone areas (Revere Beach Backshore, Point of Pines, North Gate, Town Line Brook, East Saugus, Lynn, Upper Saugus River and Shute Brook, and the estuary areas for which protection of approximately 5,000 residential, commercial, industrial and public buildings is being considered.

4.03 In the fall and winter of 1985/86 meetings were held with Federal, State and local officials, Congressional interests and State legislators to determine their interests and concerns for a regional study called: "Saugus River and Tributaries, Flood Damage Reduction Study, Lynn, Malden, Revere, and Saugus, MA." The study would investigate both local protection plans to protect individual areas separately, as well as a regional plan. The favorable response received at the meetings and from subsequent letters resulted in approval of the study and receipt of study funds from Congress. Investigations proceeded to identify the concerns, extent of flooding problems, potential solutions and their impacts.

B. Public Concerns

4.04 The communities of Lynn, Malden, Revere and Saugus are concerned about the economic and social impacts of repeated serious coastal and estuarine flooding in the Study Area.

4.05 Concerns about impacts of the construction of flood protective measures are primarily related to impacts on the 1660 acre Saugus and Pines Rivers Estuary, the largest remaining estuarine ecosystem within close proximity to Boston. These concerns have been expressed in terms of both direct physical and secondary impacts. Impacts on vegetated wetlands has been a leading area of concern. Other resources such as clam flats, and other intertidal and subtidal habitats are also of concern.

4.06 As important as direct physical impacts is the question of indirect impacts. Significant interest during the coordination of the study has been focused on project impacts of all alternatives on the entire estuarine ecosystem. The planning process focused most heavily on analysis of important factors related to ecosystem stability, such as volumetric exchange of water, tidal levels within the estuary, salinity, other water quality parameters, the saltwater/freshwater wetland and wetland/upland interfaces. The impacts of a floodgate structure on navigation and on the passage of fish has also been of concern.

4.07 Another area of concern has been that the construction of flood protective structures would cause induced land development pressures within the estuary.

4.08 Consistently heard during coordination, particularly with local officials, residents and other interests, were two additional concerns related to the design and operation of any flood protective structures. They are that the structures be aesthetically harmonious with their surroundings and interfere as little as possible with presently existing views; and that flood protective works be well maintained and that they be operated as proposed in this Feasibility Study.

4.09 Finally, concern has been expressed with regard to the likely continuation of rising sea levels during the economic life of the project, both from a flood protection and resource impact point-of-view, with the project in place.

C. Problems and Opportunities

4.10 Existing facilities in the Study Area do not provide sufficient protection against coastal storm events, as evidenced by the severe flooding that was caused by the February 1978 Blizzard and the flooding-related losses which continue on an annual basis. The communities remain very much concerned about the flood situation. Growth and more intensive development in this already densely built-up area, plus rising sea levels, guarantee the continuation of a dangerous vulnerability to coastal storm events and of increasing costs for the damages and disruption caused by such storms.

4.11 The lowest-lying portions of the Study Area will continue to be flooded on almost a yearly basis and will be virtually without protection during even more dangerous severe ocean storms. Repeated warnings about coastal flooding in low lying areas are heard on local radios several times a year. Residents and business owners alike are frequently reminded of the threat constantly facing them and their fear of the potential impacts of the next storm. The state-of-the art for coastal flood warning is not sufficient to accurately predict the severity of pending flooding. A forecasted surge of about one to three feet, when wind direction, duration and intensity are uncertain, can be the difference between an annual event and a 100 year storm -- wet basements or the emergency evacuation of thousands of people from 3,000 buildings, and the disruption of regional transportation systems that serve up to 100,000 people a day. The severity of the storm which may occur is often known only a short while before the storm surge hits.

4.12 The technical complexity of this regional flooding problem; the fact that it affects four separate communities, and the cost of effective solutions create a need for Federal assistance and strong local and State involvement. Beyond addressing the very serious coastal flooding problem that exists in the Study Area, a solution offers opportunities: to improve protection of the Saugus and Pines Rivers Estuary and associated wetlands; to satisfy and enhance much needed local and state-managed recreation; and to provide improved haven during coastal storm events for vessels which use the Saugus and Pines Rivers as ports of refuge.

D. Planning Objectives

4.13 The planning objectives for the study were based on an assessment of the problems, needs and opportunities in the Study Area, as determined by Corps investigation and concerns and goals of the affected communities. The degree to which the alternative plans meet these objectives, while complying with required criteria, determines which alternative will ultimately be selected. Even though the study was exempted from Massachusetts Area of Critical Environmental Concern (ACEC) requirements, the planning objectives are consistent with ACEC goals. The objectives of the study are to:

- . Reduce the potential coastal flood damage in the Study Area;
- . Reduce the coastal flood threat to public safety in the Study Area;
- . Preserve the valuable resources in the estuary--its vegetated wetlands, mudflats, rivers and creeks, tide levels, flushing volume, water quality and navigation;
- . Preserve and enhance recreational opportunities; and
- . Support the objectives of other planning agencies and complement regional long range recreational, environmental protection, and development plans.

5.0 Alternatives

A. Plans Eliminated from Further Study

5.01 Various plans were considered to meet the overall study objectives, but were eliminated from further study as they were either not economically justified or did not fulfill the study objectives. These plans included various local protection projects, several floodgate alignments and the use of less environmentally impacting structures along the river and coastal shorefront alignments. Further information can be found in the Main Report and the Plan Formulation Appendix.

5.02 Protection of the following areas by local protection projects, (dikes and/or walls) was not economically justified:

- a. Northgate Shopping Center area to the west of Rt. 107 bordering the estuary;
- b. The upper Saugus River and Shute Brook tidal areas in Saugus and Lynn, west of the Lincoln Ave. Bridge;
- c. The area from behind Lynn Beach to Heritage State Park in Lynn;
- d. The areas of East Saugus:
 - (1) east of Rt. 107 near RESCO;
 - (2) bordering the Saugus River, along Ballard St. from Rt. 107 to the intersection with Eastern Ave;
 - (3) from Johnson St. west to Lincoln Ave.;
- e. The Outer Oak Island area in Revere west of the B&M railroad tracks; and
- f. The area of Fowlers Marina and Gibson Park in Revere.

5.03 Under Option 3, five alternative floodgate alignments across the mouth of the Saugus River and five gate opening schemes were considered during project planning (see Main Report). Floodgate Alignments 1, 3, 4 and 5 were not considered feasible because of lower net benefits and higher construction costs than Alignment 2. Also Alignments 3, 4 and 5 included no protection for Point of Pines. Gate openings FC, N1, N2 and N3 were not carried through because they did not provide safe flows for navigation for either existing conditions or most likely future flow conditions. Gate opening EN did not provide any significant benefits for navigation over the selected N4 plan. Refer to the Main Report for further information concerning the alignment and gate opening analysis.

5.04 Alternative to being at the mouth of the Saugus River, floodgate alignments were considered at the mouth of the Pines River, and on the

east side of the B&M railroad bridge, on the Pines River (see Plan Formulation Appendix). These alignments were economically justified. However, they were eliminated from further study because of the lack of public interest, a high direct impact on vegetated wetlands, and no protection for the city of Lynn, the Upper Saugus River and Shute Brook areas or for Point of Pines, and low net economic benefits.

5.04A Under Option 1 the use of all walls along the river alignments to greatly reduce wetland impacts was eliminated due to cost, and to no overriding reasons to carry the alternative any further in the study.

B. Without Conditions (No Action)

5.05 The following paragraphs describe conditions within the Study Area that are expected to occur in the absence of any Federal action to address the planning objectives discussed earlier and in the Main Report. Importantly it is expected that application and enforcement of Federal, State and local regulations pertaining to alterations of the saltwater estuary, will continue to limit significant encroachment into the estuary. Some of these regulations include: compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act under the Corps Regulatory Program, Commonwealth of Massachusetts Wetlands Protection Act, Waterways Licensing Program (Chapter 91) and local conservation laws. In addition, heightened awareness and greater environmental protection of the Saugus/Pines Rivers Estuary will be afforded under its 1988 designation as a Massachusetts Area of Critical Environmental Concern (ACEC).

5.06 Nevertheless, due to the limited sources of agencies to monitor and enforce wetland regulations, growing pressures to develop and fill wetlands are expected to continue to result in some loss of wetlands. That loss may be less than the historic rate of about 0.5 acres per year because of the increased level of protection provided under the ACEC designation.

5.07 The possible exception to the above assumption on significant encroachment into the estuary is planned improvements to existing, or construction of new, public roads or transportation facilities. The possible work includes:

. A "Revere Connector" highway embankment from Route 1 to Route 1A that may be built in the distant future could result in the filling of up to 60 acres of saltmarsh and isolate up to an additional 200 acres from tidal flooding depending on the precise location and design of the project. If the highway is located above the marsh, on piers, impacts would be significantly reduced.

. The extension of the MBTA Blue Line adjacent to the existing B and M Commuter Line from Revere to Lynn, also anticipated for the distant future, could result in the filling of up to 15 acres of saltmarsh and up to two acres of common reed marsh. It is assumed here that the bridges over the Pines River and Saugus River will be designed so as not to increase constriction of tidal flow.

. Development of the B&M Commuter Rail Station and 1,000 space parking lot on the Saugus landfill off Route 107 within five years may result in the filling of up to an additional ten acres of saltmarsh.

5.08 The three future transportation plans could result in the filling of a total of up to approximately 90 acres of wetland and the isolation and possible hydrologic impact to up to an additional 200 acres. This impact would reduce the fish and wildlife carrying capacity and export capacity of the wetland as well as impacting the aesthetic quality of the area.

5.09 Without a Federal flood damage reduction project, flooding and damages from coastal storms to Federal, State and local residential, commercial and industrial properties, and major transportation arteries in the Study Area are expected to continue. Average annual damages for the Study Area are estimated at about \$12.6 million.

5.10 There are future Federal, State, and local developments planned in the Study Area that would affect various resources in the area. Descriptions of these projects follow.

5.11 Three Federal water resource projects are anticipated to be constructed within 5 years:

. The Saugus River Navigation Improvement Project would designate the Saugus River as a Federal Navigation Channel, and include dredging and maintenance of the channel and construction of anchorage areas. This project would provide anchorage and a channel for commercial vessels, and anchorage for recreational vessels. This project would require removal of 82,500 cubic yards of silty sand and gravel material. A total of 3.0 acres of intertidal and 17.8 acres of subtidal habitat would be dredged. Disposal would be at the Massachusetts Bay Disposal Site. No significant impacts to the estuary are expected from this project. Average annual benefits are estimated at \$504,000. Average annual costs are in the range of \$257,000 to \$328,000. Also, approximately 3,800 cubic yards of material would be dredged in conjunction with a related municipal maintenance and expansion project at the Saugus Lobstermans Landing. These sediments would also be taken to the Massachusetts Bay Site for disposal.

. The restoration of Revere Beach (Revere Beach Erosion Control Project) is also planned, with sand obtained from the abandoned I-95 embankment. This project would result in improved stabilization of Revere Beach seawalls and reduction in overtopping. Suitable sandfill would be placed along 13,000 feet of beach fronting the MDC Reservation. No significant impacts are anticipated. Average annual benefits are estimated at \$1,500,000 and average annual costs are an estimated \$730,000.

. The third Corps of Engineers project in the Study Area is the Roughans Point Flood Damage Reduction Project in Revere. This project consists of the construction of approximately 4,000 feet of armor stone revetment along the shore of Roughans Point to dissipate storm waves and reduce

overtopping. An earth berm would also be constructed to reduce backwater flooding as well as provisions made to handle interior drainage. The proposed project would reduce flood losses from a recurrence of a 100-year event by approximately 93 percent. This action is not expected to have any significant impacts on the environment. Average annual benefits are estimated at \$982,000 and average annual costs are an estimated \$930,000.

5.12 The fourth proposed Federal project is the Pines River Small Navigation Project in Revere. This project would provide for construction of an access channel from the confluence of the Saugus and Pines Rivers upstream to the head of navigation. An anchorage area would be dredged along the channel in the downstream area. The proposed work would impact 16.0 acres of subtidal habitat. Approximately 76,500 cubic yards of sandy/silty material would be removed and transported to the Massachusetts Bay Disposal Site for disposal. The project would allow for the transfer of potential future recreational and commercial growth to an expanded downstream anchorage. Average annual costs of this proposal are estimated at \$182,000, and the average annual benefits are an estimated \$265,000 (December, 1985 -latest figures). However, these annual benefits would be almost entirely accrued by recreational boating interests. As the selected plan is not consistent with current Federal directives of generating significant benefits to navigation-dependent commercial activities, these improvements are not recommended at this time. State or private interests could potentially accomplish the desired dredging.

5.12A At the State level the Metropolitan District Commission (MDC) has plans for construction of the Town Line and Linden Brook Flood Control Project in Revere and Malden, within the next five to ten years. In addition, the MDC also developed a Master Plan in 1979 for the Revere Beach Reservation, including a State linear park, recreation facilities, pavilion restoration, drainage improvements and other features to restore the Reservation. This work would also reduce flooding from overtopping of the seawall by stormwaters. The work is expected to be ongoing for 10 to 20 years. Additionally the MDC is evaluating the opportunities for developing, over the next five to ten years, a park along the abandoned I-95 embankment. Planning for this effort is in the embryonic stage and few details are currently available. The MDC plans to hold public meetings to solicit public input. Since many Federal and State agencies have an interest in the fate of the embankment route, including the potential for marsh restoration, coordination efforts here are expected to be extensive.

5.13 Additionally, it is anticipated that construction of a sewer project to eliminate the combined sewer overflow from Lynn's Strawberry Brook into the Saugus River will take place within five years; and the Saugus land-fill will be capped within five years (this is the site of the planned B&M Commuter Rail Station). These two actions should lead to improved water quality conditions in the estuary.

5.14 Private development is also expected within the area. The Lynn South Harbor area is expected to be developed over the next ten years. The development would likely include condominiums, retail, hotel and office buildings, marina facilities at the mouth of the Saugus River just seaward of the General Edwards Bridge, and shorefront structures. The developer would also have the responsibility to raise existing shorefront protection to reduce overtopping. Development is also planned for the Harborside Landing Condominium project in Lynn Harbor adjacent to Heritage Park, including shorefront protection, over the next five years. Additionally, condominium high rises and an enlarged marina are planned at the mouth of the Saugus River, on the Revere side, just upstream of the General Edwards Bridge, within five years.

5.15 At present there are 20 miles of state, local and private flood and erosion control shorefront structures within the Study Area. In the absence of the Federal project it is expected that continuing maintenance would be employed including both repairs and raising to accommodate sea level rise.

5.15A The rate of sea level rise is expected to increase in the future. Many estimates have been made of this change. The historic rise has been at a rate of 0.8 feet per century over about the last 70 years in this area. Substantial increases (for example, a 4.2 foot increase over the next 100 years predicted by some) would, of course, have significant physical, social and economic impacts for the Study Area. Further discussion of sea level rise is found in Chapter 8.

5.16 Overall, the Study Area is a mature region which is expected to continue its role in the economic makeup of the greater Boston metropolitan region. No wide swings in population, employment or industrial mix are expected to occur.

C. Plans Considered in Detail (including Mitigation)

5.17 Project planning resulted in three basic options to be considered as the final array of alternatives that would address all or part of the study objectives. These alternative plans are described in greater detail in the Main Report. Mitigation of project impacts to various significant resources is a component of the planning process during the study phase. Where necessary, practical mitigation procedures are implemented in the construction, operation and maintenance phases.

5.18 The use of an interdisciplinary planning team composed of environmental scientists and engineers has fostered the development of three options that fulfill the study purpose while avoiding many potential environmental impacts through careful design. Mitigation procedures have been and will continue to be used to minimize, rectify, reduce or eliminate project impacts and compensate for those impacts that are unavoidable. A Mitigation Incremental Analysis is provided in Chapter II of Appendix K - Environmental.

Option 1- Four Structural Local Protection Plans

5.19 This option would involve construction of 8.8 miles of structures that would reduce flood damages to 3,950 buildings in the areas of Revere Beach Backshore, Town Line Brook, East Saugus and Lynn and reduce flooding of the MBTA Blue Line and Routes 1A and 107, as well as on local streets behind the LPP structures (Figure 5.1). The structural alignments comprise:

- . 5.9 miles of dikes and walls along the edge of the estuarine wetland and the banks of the Saugus and Pines Rivers (part of the Revere Beach Backshore and Lynn LPPs and all of the East Saugus and Town Line Brook LPPs),

- . 1.8 miles of stone-faced dikes and walls (including raised existing walls) along the Lynn Harbor shorefront (part of the Lynn LPP),

- . 0.6 miles of earth dike (to be known as the Park Dike) on high ground with retaining walls at the MDC Park Reservation behind the Revere Beach shorefront and to be turned into parkland (part of the Revere Beach Backshore LPP),

- . Build a sluice gate on the concrete headwall of the Sales Creek interior drainage culvert passing under Revere Beach Parkway. The gate would prevent the backing up of floodwaters which overtop Bennington Street into Suffolk Downs during coastal tidal events generally exceeding a 10-year recurrence (part of the Revere Beach Backshore LPP), and

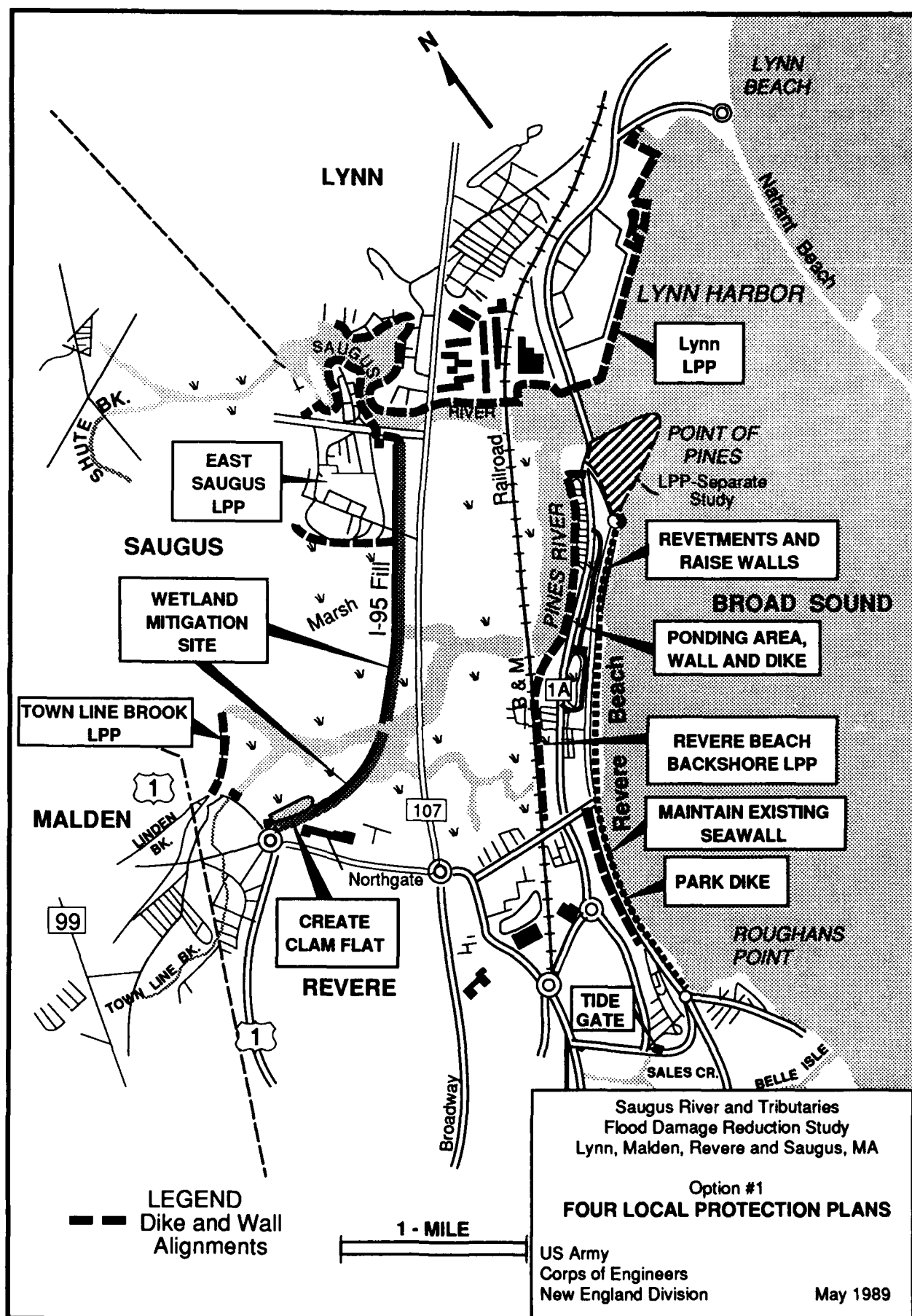
- . raise 0.3 miles of walls by two feet and construct 530 feet of revetment beneath sand placed for the authorized Revere Beach sanding project, both at the north end of Revere Beach, and maintain a 40 acre ponding area along Route 1A with a 0.2 mile containing wall and dike behind the beach at the south end of the ponding area (part of the Revere Beach Backshore LPP).

- . Continued maintenance of the existing seawalls and beach along Revere Beach would be required to prevent excessive erosion and increased overtopping along the shorefront.

5.19A Flood preparedness plans would also be developed for Option 1.

5.19B Construction of Option 1 would take two years, with concurrent construction of the four LPPs.

5.19C Option 1 LPPs would provide protection ranging from the SPN event for the Revere Park Dike area, the 500 year event for Lynn and East Saugus and to the 100 year event for north Revere Beach, the Pines River, and Town Line Brook.



5.19D The local protection projects would be the responsibility of the Non-Federal Sponsor(s) to arrange for the non-Federal share of the costs. The Non-Federal Sponsor(s) would then enter into an agreement(s) with the Federal Government for construction of the projects. Non-Federal Sponsor(s) would be responsible for 35% of the project first costs attributed to flood control and 100% of the operation and maintenance costs.

5.20 The first cost of this plan is \$62.4 million; the average annual costs are \$5.98 million, average annual benefits are \$7.16 million and the BCR is 1.2. The average annual net benefits are \$1.18 million.

5.21 As described more fully in Chapter 7 - Environmental Effects, implementation of Option 1 would be anticipated to impact various significant National Economic Development (NED) and Environmental Quality (EQ) resources.

5.22 Under Option 1, 17.7 acres of vegetated wetlands and 14.6 acres of intertidal habitat would be lost. Temporary construction impacts would occur. Wildlife would be displaced from the areas where the structures are built. The presence of dikes and walls in the Study Area would also cause aesthetic impacts and visual access restrictions.

Option 1 Mitigation

5.23 The mitigation of project impacts is a functional component of the planning process during the study phase, as is, implementation of practical mitigation procedures in the construction, project impacts (operation) and maintenance phases. The following paragraphs describe the mitigation procedures proposed for this option for the construction, project impacts and maintenance phases.

Option 1 Construction Phase Mitigation

a. Shellfish Habitat

5.24 The construction of dikes and walls will require temporarily impacting approximately 2.9 intertidal acres. These 2.9 acres can be classified as habitat for National Economic Development Resources since high densities of softshell clams, *Mya arenaria* are present. The total 2.9 acres of intertidal habitat also provides EQ benefits through benthic invertebrate productivity and finfish (high tide) and waterfowl (low tide) forage.

5.25 During construction, a maximum of two years would be required to finalize construction on any given LPP. The shellfish concentration areas will subsequently require approximately four years to regain their productivity (through larval recruitment) to pre-construction densities. This acreage will undergo post-construction benthic recolonization without significant loss to NED or EQ resource productivity.

5.26 This represents a maximum loss of 17.4 acre-years (2.9×6 years = 0.2 acre over the 100 year project life) of shellfish habitat. The mitigation of temporary construction impacts is combined with the mitigation for project footprint impacts, i.e., construction of habitat for Mya arenaria at the I-95 fill site described later. In addition, prior to construction the impacted flats would be harvested to transplant clams into the lower (non-impacted) intertidal zone.

b. Construction Activities

5.27 Project construction would cause noise, dust and traffic impacts. About 70 truck trips per day would be required, for two years, congesting traffic. The traffic noise and traffic congestion will be mitigated by confining the majority of heavy equipment access and egress to off-peak, daytime traffic hours.

5.28 The activity of construction will also temporarily disturb the human environment and displace wildlife which will avoid excessive equipment noise and dust. Proper equipment mufflers and dust covers for trucks and stockpiles will be required to minimize this impact.

c. Erosion/Spills

5.29 Erosion of materials from stockpiles and exposed/disturbed substrate has the potential to increase suspended solid levels in the estuarine system as well as introduce small quantities of particle adsorbed oils or contaminants. A potential also exists for accidental oil spills from equipment. Mitigation of these project effects will be attained by requiring placement of appropriate sedimentation and erosion control (S&E) devices (hay bales, silt curtains, etc.) proximal to the construction activity near sensitive habitats and drainage courses. Stockpiles of material will be covered and exposed earth will be surrounded by S&E systems until graded and replanted.

5.30 Areas of construction requiring activity close to the tidal creek/waterway system will also have a potential to increase suspended solids/contaminant load to the estuary. In particular, the upper estuary construction activity (i.e. the Lynn and East Saugus LPPs) will be restricted to a fall/winter time frame to avoid suspended solids inputs during the spring spawning runs of anadromous fisheries as well as peak egg and larval concentrations in the water column and the most sensitive vegetative growing season.

d. Debris

5.31 All construction activity will be closely inspected to assure that debris, excess material and waste is completely removed. This will include a post-construction inspection of the entire Study Area for construction-related debris, with particular emphasis on tidal creeks. Assurance that project flotsam does not restrict hydraulic conveyance in the creeks would rectify any potential marsh degradation.

e. Resource Disruption

5.32 During construction of various LPP sections up to about ten acres of vegetated wetlands will be temporarily impacted. Other sensitive habitats have the potential to be trampled by heavy equipment activity. These temporary habitat impacts would be minimized by imposing equipment restriction to upland or disturbed habitats, restoration of disturbed vegetation (wetland and upland) by regrading and active replanting, creation of buffer zones and use of wildlife enhancing vegetative cover (e.g. Bittersweet, Elderberry, Dogwoods, Blackberry, Blueberry and Staghorn Sumac) along the backs of dikes and walls, where practical.

5.33 The construction of the LPPs could have an impact on prehistoric or historic period resources which may be buried beneath the marsh vegetation. Since any evidence of past human activity located within the right of way for the dikes and walls would be destroyed during construction, an archaeological survey, designed to locate archaeological deposits that are buried beneath the current marsh vegetation, would need to be conducted.

5.34 At this time, only portions of the Revere Beach Backshore LPP, in the vicinity of Oak Island, and the East Saugus LPP appear to have any potential for containing buried dry-land surfaces.

5.35 Intensive locational surveys would have severe impacts on the marsh environment and should only be conducted if the LPP's are authorized for construction. Mitigation would consist of professional data recovery to retrieve archaeological information contained in the sites encountered. Because of the difficult excavation techniques required, mitigation is likely to be costly and time-consuming. Three years, at a minimum, should be allowed to complete site discovery, site evaluation and data recovery (mitigation) phases and the associated coordination with the State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (ACHP).

f. Public Access

5.36 The general public will be excluded from traversing construction sites for safety reasons. This will impede direct access to parts of the system during construction but when weighed against safety concerns, is an unavoidable impact. Recreational fishermen, birdwatchers or passive recreators will be required to seek other routes of access during construction.

Option 1 Project Impacts Mitigation

5.37 Structures constructed under the Option 1 scenario will impact shellfish National Economic Development resources by destroying intertidal shellfish beds. Environmental Quality (EQ) resources impacted include destruction of intertidal habitat and wetlands under the structures' footprints, displacement of wildlife by habitat loss and the alteration of aesthetic resources, from both the visual impacts of the structures as well as the visual access restrictions caused by the structures.

a. Shellfish Habitat

5.38 The establishment of the Option 1 structures would directly impact 14.6 acres of intertidal habitat. These 14.6 acres sustain significant concentrations of recreationally and commercially valuable shellfish, i.e. the clam Mya arenaria. This significant National Economic Development (NED) Resource would be compensated for by establishing new intertidal habitat and transplanting clams into the newly constructed habitat. Shellfish will be actively transplanted from the resident Sea Plane Basin Mya population.

5.39 Specifically, I-95 fill site adjacent to the southern shore of the Pines River would be regraded and converted to sand flats and intensively managed for clams for compensation of intertidal losses from Option 1. This mitigates 14.6 acres of direct habitat loss through replacement with structures plus 0.2 acres of construction impact (17.4 acre-years of productivity over the 100 year project life).

b. Wetlands Loss/Degradation

5.40 The Option 1 LPP structures would impact wetlands and wetland quality throughout the marsh system. These Environmental Quality ecological impacts can be mitigated on a 1:1 ratio. The total wetland area lost would be approximately 17.7 acres. About 1.9 acres of wetlands that would otherwise be impacted by hydrologic impedance as a result of placement of the LPP structures would be served by automated tide gates to allow continued flushing as at present.

5.41 The elimination of 17.7 acres of wetland under Option 1 is a significant impact on EQ resources which would require mitigation. Ample opportunities to mitigate for the impact by constructing wetland are provided by the abandoned I-95 embankment fill and the Saugus Racetrack. Approximately 60 acres of potential mitigation area are provided by the embankment. The Racetrack area provides an additional three acres.

5.42 The wetland would be constructed from the I-95 embankment and would be linear in order to avoid potentially increasing flooding in the residential areas west of the embankment. Wetland would be constructed by removing only 100 feet from the width of the 200-240 foot wide embankment. An area 100 feet wide by 7,710 feet long would provide for 1:1 mitigation of wetland losses. The wetland could be created on either the west or east side of the embankment. Wetland plants would also be planted around the landward (embankment) edge of the intertidal flat mitigation area on the I-95 site south of the Pines River opening. This would stabilize the upland to intertidal flat transition zone which would enhance the value of the flats.

5.43 The wetland construction sites would be graded to the elevation of the surrounding marsh. Approximately 10% of the area would be graded on a slope to the elevation of approximate mean high water along an irregular

line and planted with saltmarsh cordgrass (Spartina alterniflora). The maximum and minimum elevation of the native cordgrass would be used as a guide for the planting elevations. The lowest two rows of cordgrass would be planted on 18 inch centers and the higher elevations would be planted on three foot centers.

5.44 Approximately 90% of the site would be graded to the elevation of the high marsh. Culms of spike grass (Distichlis spicata) and saltmeadow grass (Spartina patens) would be planted on three foot centers. This combination would be used to take advantage of the rapid colonization of spike grass and the dense colonization of saltmeadow grass. This will help lessen the time lag between marsh construction and attainment of full marsh plant cover.

5.45 It is estimated that at least 10 years will be required for the constructed wetlands to approach the ecological value of the wetlands they are replacing. This represents a 177 acre-year loss in productivity. Over the 100 year project life this will be compensated by establishing 1.8 additional acres of wetlands, for a total of 19.5 acres to compensate for project impacts.

c. Wildlife Displacement

5.46 Ecological impacts associated with wildlife habitat displacement would result from the replacement of wildlife habitat by artificial structures (dikes and walls). These losses to Environmental Quality Resources represent alterations in the wildlife component of the marsh system. Mitigation is proposed by the aforementioned shellfish and wetland habitat constructions as well as by substituting environmentally enhanced project structures for natural and/or pre-project conditions as discussed below.

5.47 The location of dikes and walls in the Option 1 scenario impacts the ecotone (area of transition between wetland and upland) which is a highly valuable habitat. Construction of the dikes in the ecotone will add additional stress to those species which have already been forced into a marginal habitat situation. Shrubby vegetation along the wetland perimeter is used not only for food and cover by resting wildlife species but also as a travel corridor. Loss of this habitat will be mitigated through plantings of shrubbery attractive to wildlife along the backs of dikes and walls. Preferred food and cover species would include: Bittersweet, Elderberry, Dogwoods, Blackberry, Blueberry and Staghorn Sumac.

5.48 Additionally, the enhancement of mussel habitat (rock surface is part of the structure's designs) along many of the Option 1 structures could mitigate impacts to waterfowl wildlife, including the Black Duck, a US Fish and Wildlife Service species of special concern identified in the North American Waterfowl Management Plan.

d. Shoreline Views and Vistas

5.49 Alterations in the Environmental Quality Resources of a coastal system are ultimately perceived by humans as changes in the aesthetic character of their habitat. From pristine wetlands to urban ports the character of a "Yankee" New England Coastline is one of sharp contrasts. The view from one's house seaward, if unobstructed, is a valuable attribute of real estate property. The implementation of Option 1 entails the placement of man-made structures in the ecotone or transitional areas between the residents they are intended to protect and the environment they must hold at bay. The structures cannot be natural since they are by design of material to resist natural forces. Full mitigation of the obtrusiveness and visual hinderance of these structures would therefore not be attainable; at best architectural design, including appropriate plantings, could lessen impacts and will receive attention during the design phase of the project.

Option 1 Maintenance Phase Mitigation

5.50 Impacts associated with the maintenance of project structures are similar to construction phase impacts. In addition to mitigation for construction-like maintenance impacts, some of the project mitigation features will require maintenance. These include inspection, grading and/or additional transplant for shellfish habitat resources, maintenance of hydraulic conveyances to mitigation areas and replantings of unsuccessful wetlands or wildlife enhancing flora.

a. Maintenance Activities

5.51 All maintenance activities, as in the construction phase will use appropriate access and egress routes, avoid destructive travel or working in sensitive wildlife habitats, and replant, regrade or replace any disturbed areas. Vehicle activity and traffic interruptions would be restricted to off-peak hours.

5.52 Proper sedimentation and erosion controls will be maintained during all maintenance activity. Debris, excess material and waste will be completely removed. All hazardous materials, petroleum products and chemicals stored or used in project upkeep will be properly handled and discarded so as not to contaminate the environment.

5.53 The human activity in the project area as well as various project upkeep activity will produce debris. The potential exists for plastic and wood flotsam/jetsam to impede hydraulic conveyance to the mitigation areas. Efforts will be made, as needed, to remove obstructive debris from creeks and ditches supplying the mitigation areas to maintain the integrity of the mitigation habitats constructed.

b. Mitigative Success

5.56 The site of shellfish transplanting will be surveyed four years post-construction and wetland construction and enhancement sites will be surveyed two and four years post-construction. Other plantings for mitigative purposes will also be surveyed at this time for persistence and durability.

5.57 The shellfish densities would be expected to approach a 2nd year recruitment population within four years post-construction. If the 14.8 transplanted acres do not contain any shellfish, another transplant will be attempted as well as an ecological study of potential reasons for failure.

5.58 Mussels are expected to recolonize the new Option 1 structures, mitigating losses of isolated colonies and populations present on existing shoreline structures. Mussels are important forage for finfish and waterfowl, especially wintering Black Ducks seeking ice-free forage areas. The Option 1 structures will be surveyed for successful mussel recruitment in year four post-construction. If mussels have not naturally colonized the structures, a transplant of mussels and substrate will be attempted. An ecological assessment of epifaunal colonization will be performed to determine reasons for failure of mussel set.

5.59 The marsh creation site will be examined for requirement of fertilization two years post-construction. After four years of post-construction growth the new marsh will be surveyed for success rates (density, composition, etc.). A report of the marsh construction methods will be made available to local concerns for future reference in similar applications.

Option 2- Nonstructural Plans

5.60 Option 2 would reduce the vulnerability to flooding up to the 100-year flood level through flood preparedness plans and floodproofing of about 240 buildings. In addition to a flood warning system, other measures would include raising buildings, providing watertight enclosures for utilities and sealing windows and doors with waterproofed closures. Floodproofing would protect about 7% of the structures in the SPN floodplain. Thus, floodproofing would only minimally address the flooding problems. Studies also determined that coastal storm forecast systems do not yet exist in a sophisticated enough form to provide effective early warning in this Study Area. Only a foot or two difference in tide levels lies between a storm that is a minor disturbance and one that poses great threat to human life and/or causes severe damages. At the present time, depending on which circumstances occur, this information is often known only shortly before the event hits the Study Area.

5.60A Construction work to floodproof any given building would probably take on the order of up to 3-4 months.

5.61 The nonstructural plans would be the responsibility of the Non-Federal Sponsor(s) to finance the non-Federal share of 25% of the project first costs and 100% of the operation and maintenance costs.

5.62 The first cost of this plan is \$7.4 million; the average annual costs are \$0.7 million, average annual benefits are \$1.4 million and the BCR is 2.0. The average annual net benefits are \$0.7 million.

5.63 There would be no significant impacts associated with this plan. Any impacts to be mitigated would be restricted to the normal construction activity of floodproofing (access to and egress from structures would be limited to normal working hours), the control of erosion or spills from stockpile material and avoidance of sensitive habitats.

Option 3-Regional Saugus River Floodgate Plan

5.64 This option, with a total of 3.5 miles of structures, would reduce flooding throughout the entire Study Area (5,000 buildings plus all major transportation arteries serving the Study Area and Boston's north shore and local streets inside the floodgates and behind shorefront structures). It would include:

- . A floodgate structure across the mouth of the Saugus River approximately 700 feet downstream of the General Edwards Bridge, and shorefront protection along Revere Beach, Point of Pines and Lynn Harbor (Figure 5.2). The floodgate structure (Alignment 2, gate scheme N4) would be approximately 1300 feet long, and include a 730 foot long gated concrete wall to house the navigation and flushing gates. Approximately 560 feet of walls would tie the structure into the shoreline. Approximately 8,800 square feet of gated openings at mid tide, including a 100 foot wide by 33 foot high navigation miter gate with unrestricted vertical clearance and ten fifty foot wide by fourteen foot high flushing tainter gates would be required.

- . Along the Lynn harbor shoreline, about 9,000 feet of dikes and walls (including raised existing walls) would be constructed to reduce most overtopping.

- . Behind the Revere Beach seawall in the vicinity of the Metropolitan District Commission (MDC) police station, 8.5 acres of vacant land would be raised with a 3420 foot (0.6 mile) long earth dike (to be known as the Park Dike) and turned into parkland. It would prevent tides which overtop the seawall from reaching developed areas.

- . A 20 acre ponding area located behind the north end of Revere Beach would be acquired in fee or easement and protected for tidewaters overtopping this area behind the beach, and a 500 foot long containing wall would be constructed at its south end.

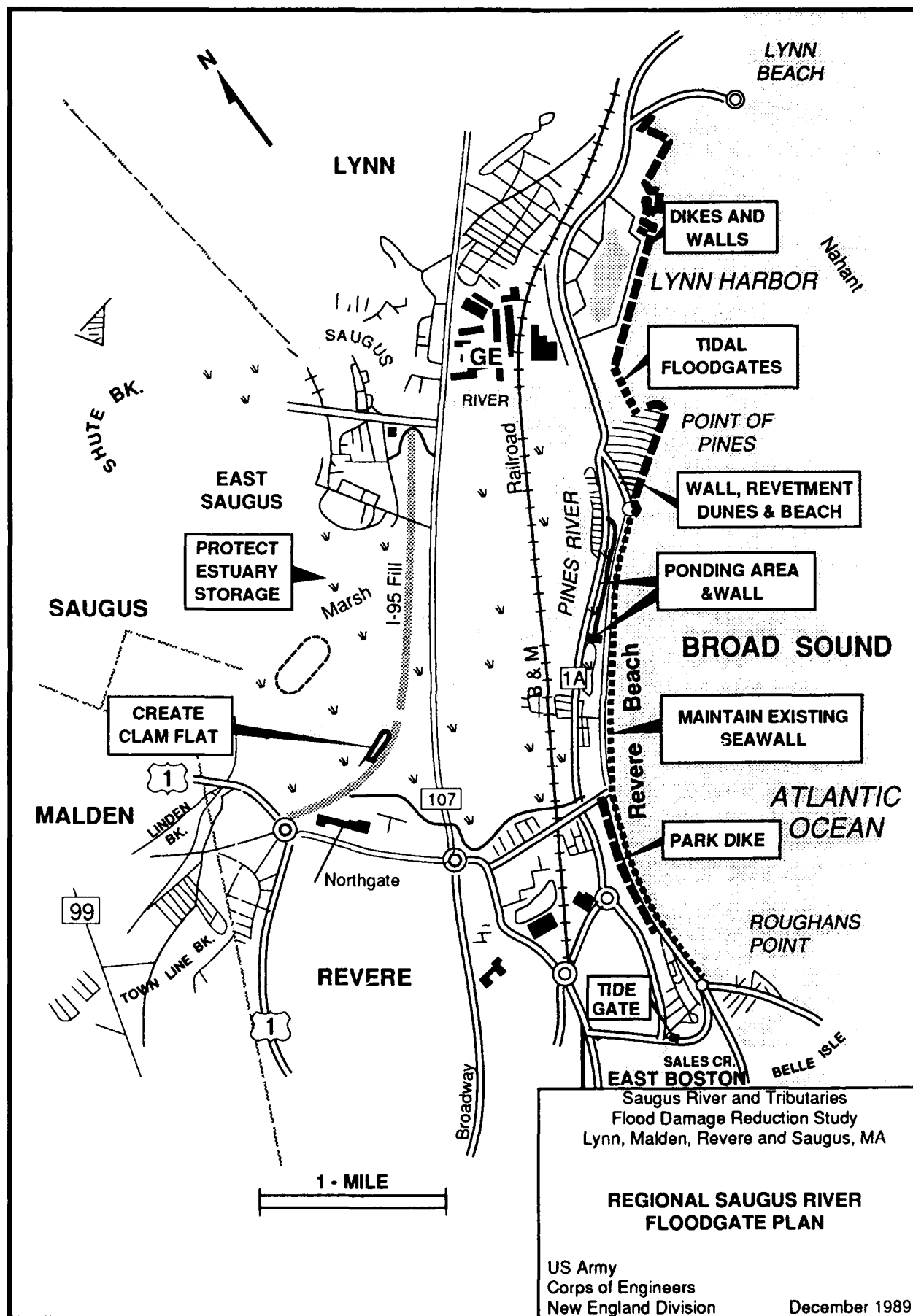


Figure 5.2

. A sluice gate would be built on the concrete headwall of the Sales Creek interior drainage culvert passing under Revere Beach Parkway. The gate would prevent the backing up of floodwaters which overtop Bennington Street into Suffolk Downs during coastal tidal events generally exceeding a 10 year recurrence.

. Continued maintenance of the existing seawalls and beach along Revere Beach would be required to prevent excessive erosion and increased overtopping along the shorefront.

. Protection of 5,400 acre-feet of estuarine flood storage area would be required to maintain existing floodwater storage needed during rare coastal storm events coincident with runoff from the watershed and some overtopping of the shorefront. Protection would be afforded through acquisition in fee or easement of about 1660 acres of the estuary and monitoring and improved enforcement of existing regulations. Improved enforcement would be provided through the ACEC designation and provisions, as part of the operation of the project, of an environmental (enforcement) manager.

. At the Point of Pines shorefront, 1550 feet of armor stone revetment are needed to reduce wave overtopping between Carey Circle and Alden Avenue. Northward from this point, 1600 feet of revetment are needed under existing sand dunes, which would tie into 1140 feet of new and raised walls to tie into the floodgates at the mouth of the Saugus River. The sand dunes would be restored with sand and dune grass and protected with crossovers and fences for a length of 1720 feet. The beach would be nourished along about 3000 feet of the shorefront in front of the revetments and dunes with clean natural sand (17,000 cubic yards from under the restored dunes). The residential side of the Point of Pines structures would be landscaped.

. Development of flood preparedness plans.

5.65 Navigation and flushing gates would maintain both safe navigation and the natural flushing of the rivers and wetlands by remaining open until the threat of a flood. Gates would be closed if the ocean tide was expected to rise to 8 feet NGVD (estimated start of damages) or above. The gates would normally be closed at about 7 feet NGVD for storage of interior runoff and containment of surface waves and normally be closed for one to two hours, until the tide recedes to the level in the estuary. Closure at a somewhat lower elevation for a somewhat longer period would take place on rare occasions, due to severe conditions. Closure would be estimated to occur between 2 and 3 times per year gradually increasing to 40 times with one foot of sea level rise. Most closures would take place between mid-October and mid-February.

5.65A Disposal of approximately 114,200 cubic yards of dredged material would be at the Massachusetts Bay Disposal Site, about 15 nautical miles east of Lynn Harbor.

5.65B Construction of all features except the floodgate would take about one year, followed by floodgate construction which would take about 3 years.

5.65C Option 3 would provide SPN protection to nearly the entire Study Area, except Point of Pines and the Garfield School Area at the south end of Revere Beach, where 100 year protection would be provided. Also, damages at the north end of Revere Beach would be only partially reduced up to the SPN level.

5.65D The Non-Federal sponsor would be responsible for 35% of the project first costs for flood control, 50% for recreation features, and 100% of the operation and maintenance costs.

5.65E At 1988 price levels, the first cost of this plan is \$85 million; the average annual costs are \$8.6 million, average annual benefits are \$11 million and the BCR is 1.3. The average annual net benefits are \$2.3 million.

5.65F This plan is the National Economic Development (NED) plan as it has the greatest net benefits and is supported by the sponsors - the Metropolitan District Commission and four communities. It provides the highest level of flood protection, and would not compromise the estuarine ecosystem. It is therefore the recommended plan.

5.66 Under Option 3, 2.0 acres of intertidal habitat and 1.0 acre of subtidal habitat would be lost. No vegetated wetlands would be lost. Temporary construction impacts would occur. Wildlife (primarily water-fowl) would be displaced from areas where the structures are built and the structures would cause aesthetic and visual access impacts, however these impacts would be much less than in Option 1. The floodgate would cause minimal impingement/impedence impacts to fisheries. Acquisition and protection of estuarine flood storage area would reduce wetland losses due to illegal fills or other activities.

Option 3 Mitigation

Option 3 Construction Phase Mitigation

5.67 The construction of various intertidal and subtidal structures will temporarily impact 0.6 acres of intertidal shellfish (Mya arenaria - 50/m²) habitat. Mitigation of this impact will be achieved through recreation of shellfish habitat over the toe of the dikes along Lynn Harbor. The temporary impact will primarily occur during the first two years of construction and require a four year recolonization process. The mitigation therefore will replace in-kind 3.6 acre-years (0.6 acres x 6 years) of habitat ameliorated over the 100 year project life would require only 0.036 acre of permanent replacement habitat. This would be more than compensated for by the 0.5 acre of habitat created at the toe of the Lynn

Harbor dikes. In addition, prior to construction the flats will be harvested to transplant clams into the lower (non-impacted) intertidal zone.

5.68 Dredging impacts will be minimized by avoiding when possible non-cofferdam activity during the March-April spawn of winter flounder, the spring runs of anadromous and catadromous fisheries, spring and summer high egg and larval densities in the water column, and peak fall season densities of fish in the area. Therefore dredging will preferably occur November through February.

5.69 The alternate floodgate alignments were all evaluated for the need to dredge a temporary channel under the General Edwards Bridge and/or requirements of recreational craft relocation during construction. Floodgate Alignment 2 was selected as the preferred alternative and avoids these construction impacts.

5.70 Mitigation of construction activities would be similar to those discussed for Option 1, including minimization of noise, dust and traffic impacts. About 36 truck trips per day would occur during about a year of construction and an average of twelve per day for three additional years. The traffic noise and traffic congestion will be mitigated by confining the majority of heavy equipment access and egress to off-peak, daytime traffic hours. The activity of construction will also temporarily disturb the human environment and displace wildlife that are avoiding excessive equipment noise and dust. Proper equipment mufflers and dust covers for trucks and stockpiles will be required to minimize this impact. Prevention of erosion and spills would be carried out by proper sedimentation and erosion control devices and covering of stockpile materials. Debris, excess material and waste will be removed. A post-construction inspection of the entire Study Area for construction-related debris will be made.

5.70A Resource disruption during construction will be minimized by imposing equipment restriction to upland or disturbed habitats, restoration of disturbed vegetation, creation of buffer zones and use of wildlife habitat-enhancing vegetative cover along the backs of structures, where practical. Public access will be limited at construction sites.

Option 3 Project Impacts Mitigation

a. Shellfish Habitat

5.71 Two (2.0) acres of intertidal habitat sustaining significant concentrations of recreationally and commercially valuable shellfish, i.e. the clam, Mya arenaria and mussel, Mytilus edulis as well as 1.0 acres of subtidal habitat supporting no significant NED resources would be lost under Option 3. Additionally 0.6 intertidal acres will be temporarily impacted during construction. The 4.5 acres of subtidal habitat temporarily impacted by dredging will require no mitigation since significant NED resources are absent and the normal biota will rapidly recolonize the

newly dredged sands. Similarly, 1.0 acre of subtidal habitat temporarily lost to the floodgate footprint and then regained as subtidal in dredging will not require additional mitigation, with no significant resources being present. The net total three acres of subtidal and intertidal habitat lost will be mitigated by habitat construction at the I-95 fill site and habitat enhancement along the Lynn Harbor dikes and the floodgate structure, on at least a 1:1 mitigation ratio.

5.72 A 4.2 acre mitigation site will be excavated on the I-95 embankment near the Pines River. It will consist of 2.0 acres of intertidal flats below MSL, about 0.7 acre of intertidal transition habitat, 1.0 acre of subtidal habitat, and about 0.5 acre of fringing vegetated wetland to stabilize and diversify the site. A 2.3 acre dike and a ten foot buffer zone will also be provided because of design constraints at this location. The I-95 fill would be removed and graded on a slope between the level of a ten foot buffer zone, through the level of the low marsh to subtidal habitat. Shellfish would be transplanted from the Sea Plane Basin to the newly constructed habitat. Additionally, 0.5 acres of intertidal habitat would be reclaimed from behind the bulkhead at the toe of the Lynn Harbor dikes. Only a small portion (0.036 acre) of the 0.5 acre mitigation potential of these new sand flats is targeted against project impacts of this time.

5.73 Additional features of the habitat construction will be included to increase intertidal slope and niche diversity. The intertidal shore will be stabilized with Spartina alterniflora in some areas and left as intertidal sandflats in others. The plantings will stabilize the slope and reduce sediment movement from upland erosion onto the clam habitat. This diversity will enhance wildlife use of the area as well as provide finfish habitat, both mitigations for impacts to these resources as discussed below.

5.74 Mussel habitat occurred in some intertidal areas impacted by Option 3 structures. The use of these mussel beds by waterfowl (e.g. Black Duck) and the commercial (NED) value of blue mussels warrant mitigation. The original project dredging limits have been revised, which significantly minimizes loss of mussel habitat. Construction of the Lynn Harbor dikes inland of the existing bulkhead also significantly reduces impacts to mussel habitat. The Lynn Harbor dikes will provide additional mussel substrate once they are built. This is expected to provide an increase in mussel habitat area over that lost and should fully mitigate loss of mussel habitat.

b. Impingement/Impedence to Finfish and Lobsters

5.75 Some minimal impingement/impedence is expected to impact eggs, larval, juvenile and small adult organisms. The gate structure itself would be designed to have rounded corners to minimize egg/larval impingement on sharp corners as they are swept through the structure with the tides. Most tainter gates are flush with the bottom which avoids

impacting fisheries movement. Where topographic features will not permit tainter gates to be flush with the substrate, rock/cobble slopes will be constructed to reduce erosion and assist smooth hydraulic flow and demersal species of finfish and lobsters in transiting the structure. The 100-foot navigation gate vertical bottom sill (about 18 inches high) would have a concrete ramp on the river side only, thus impeding lobsters entering the estuary; however, they would move laterally to cross at the tainter gates. The Spartina alterniflora fringe constructed at the mitigation area will provide good cover for bait fish and enhance the potential production of juvenile finfish in the estuary possibly balancing any increased destruction of larval or juvenile fish passing the gates. Additional compensation would be afforded by acquisition, monitoring and protecting the estuarine flood storage area as a project feature.

c. Wildlife Displacement

5.75A Ecological impacts associated with wildlife habitat displacement will result from the destruction of primarily waterfowl habitat by artificial structures. Mitigation for these losses to Environmental Quality Resources is proposed on a 1:1 basis by the shellfish habitat construction from the I-95 fill area already described.

Any losses of shoreline vegetational cover or forage habitat by project implementation will be mitigated by plantings of beach dune grass (Ammophila breviligulata) along beach dune areas and plantings such as Bittersweet, Elderberry, Blackberry and Blueberry along dikes.

5.76 Additionally, the enhancement of mussel habitat (rock surface is part of the structures' designs) along the Lynn Harbor dikes would be expected to mitigate impacts to waterfowl, including the Black Duck, a U.S. Fish and Wildlife Service species of special concern identified in the North American Waterfowl Management Plan.

d. Shoreline Views and Vistas

5.77 Full mitigation of the obtrusiveness and visual hinderance of structures for Option 3 is not attainable; at best architectural design could lessen impacts. The floodgate and associated structures would be designed with consideration of aesthetic mitigation. Colors and textures would accentuate ambient character. Environmentally and aesthetically advantageous planting will partially mitigate the unnatural obtrusiveness of the structures.

Option 3 Maintenance Phase Mitigation

5.78 Impacts associated with the maintenance of project structures are similar to construction phase impacts. In addition to mitigation for construction-like maintenance impacts, some of the project mitigation features will require maintenance. These include inspection, grading

and/or additional transplant for shellfish habitat resources, maintenance of hydraulic conveyances to the mitigation area and replantings of unsuccessful wetlands or wildlife enhancing flora.

a. Maintenance Activities

5.79 Efforts to mitigate construction-like maintenance impacts will be similar to those in Option 1; the addition of the floodgate structure should require no additional unique mitigation steps. Efforts will be made, as needed, to remove obstructive debris from creeks and ditches supplying the mitigation area to maintain the integrity of the mitigation habitat constructed.

b. Mitigative Success

5.80 The shellfish transplanting and the construction of fringe wetlands at the mitigation site will be surveyed four years post-construction. Other plantings for mitigative purposes will also be surveyed at this time for persistence and durability.

5.81 The mitigation site shellfish densities would be expected to approach a 2nd year recruitment population within four years post-construction. If the two acres do not contain any shellfish, another transplant will be attempted as well as an ecological study of potential reasons for failure.

5.82 Mussels are expected to recolonize the new Option 3 Lynn Harbor structures, mitigating losses. Mussels are important forage for finfish and waterfowl, especially wintering Black Ducks seeking ice-free forage areas. The Lynn Harbor structures will be surveyed for successful mussel recruitment in year four post-construction. If mussels have not naturally colonized the structures, a transplant of mussels and substrate will be attempted. An ecological assessment of epifaunal colonization will be performed to determine reasons for failure of mussel set.

5.83 The fringe marsh construction at the mitigation site will be examined for requirement of fertilization two years post-construction. After four years of post-construction growth the new marsh will be surveyed for success rates (density, composition, etc.). A report of the marsh construction methods will be made available to local concerns for future reference in similar applications.

D. Comparative Impacts of Alternatives

5.84 Table 5.1 describes the base and without project condition, the impacts of the detailed plans on identified significant resources, and the economic characteristics of the detailed plans.

TABLE 5.1
COMPARATIVE IMPACTS OF ALTERNATIVES
Saugus River and Tributaries, Flood Damage Reduction Study

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Hydrology/ Hydraulics	Normal flushing in estuary. Max. astronomical high water - 7.5 ft. NGVD. 100-year flood - 10.3 ft. NGVD.	Some change with sea level rise (0.8 foot by 100th year).	No significant impact.	No impact.	Elimination of tides above 8 ft. in estuary (unless project is modified). Less than 0.1% reduction in estuarine flushing. Velocities at open gates as existing or somewhat higher.
Water Quality	Saltwater estuary; class SB waters.	Improved quality.	Temporary turbidity during construction.	No impact.	Temporary, minor concentration of pollutants behind closed gates 2 to 3 times/year. Temporary turbidity during construction.
Wetlands	1070 acres-vegetated, all in the Saugus/Pines Rivers Estuary.	Possible direct loss of up to 90 acres and indirect impact to up to 200 acres from transportation projects with mitigation likely through partial removal of the I-95 Fill. Continued losses from illegal fills, at about 0.5 acres/year with additional regulation under the Coastal Wetlands Restriction Act and increased development pressures.	17.7 acre project loss. Temporary construction impact to up to ten acres.	No impact.	No vegetated wetlands lost. Increased protection by estuary acquisition, monitoring and enforcement of existing regulations including an Environmental Enforcement Manager.

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Benthic Habitats	239 subtidal acres, 330 intertidal acres in the estuary. More along coastal shorefront. High soft shell clam density in Saugus River, upstream of Route 107, low to moderate in Pines River and along Lynn Harbor.	Some habitat loss from transportation projects and illegal fills.	14.6 intertidal acres lost. 2.9 intertidal acres impacted during construction. No subtidal impacts.	No impact.	2.0 intertidal acres lost; 2.0 subtidal acres directly impacted, but net loss of 1.0 subtidal acres. 0.6 intertidal acres impacted during construction. 4.5 subtidal acres impacted during construction.
Sandy Beaches, Artificial Shorelines	Revere Beach is highly developed for recreation, Pt. of Pines Beach less developed. Flood control structures exist in places around the estuary and along the Lynn and Revere coastal shorefronts.	Revere Beach would be nourished by the Corps' Revere Beach Erosion Control Project. Replacement and raising of non- Federal structures along the Lynn and Revere coastal shore- fronts and along the estuarine shorefront.	Temporary displacement of organisms on artificial shoreline structures being replaced.	No impact.	At Point of Pines: 0.1 acres of beach lost, 6 acres of new beach cre- ated. 1600 feet of dunes at Pt. of Pines would be removed, then restored and replanted atop new revetment. Temporary displacement of organisms on artifi- cial shoreline struc- tures being replaced.
Fish, Lobsters	Mostly recreational fishery, including anadromous and cata- dromous species of fish. Nursery area for fish and lobsters.	Impacts associated with wetland and benthic habitat loss.	Fisheries impacted by wetland & benthic habitat loss (32.3 acres). Minor temp- orary construction impacts.	No impact.	Fisheries impacted by benthic habitat loss (3 acres). Minor impedence/impingement of eggs, larval, juvenile and small adult organ- isms at the floodgates.

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Wildlife	Variety & abundance of small mammals, reptiles and amphibians, and birds. Significant wintering population of Black Ducks.	Impacts associated with wetland and benthic habitat loss.	Loss of intertidal (14.6 acres) and wetland (17.7 acres) foraging areas. Loss of estuarine edge habitat and restriction on access into and out of estuary along 6 miles of structures. Temporary displacement impacts during construction.	No impact.	Loss of intertidal/subtidal foraging areas (3.0 acres). Temporary displacement impacts during construction.
Rare, Threatened and Endangered Species	Transient or migratory birds pass thru area, occasionally stop over.	No change.	No impact.	No impact.	No impact.

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project- Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Social and Economic Factors, including Land Use, Transportation, Navigation, Recreation, Noise and Air Quality	Densely developed residential area; business activity mainly trade/services. Industry, primarily manufacturing, mostly in Lynn. Marsh development prohibited by regulation, but illegal filling continues. Outside the marsh, development depends on land availability/general economic climate. Area has well developed transportation system. Vessel fleet comprises 350 boats in the Saugus/Pines Rivers; Several hundred more in Lynn harbor. Recreational facilities in all communities, but some in disrepair. Revere Beach a major recreational focus. Noise and air quality conditions typical for the region.	No significant change in land use and business/industrial activity. Continued illegal filling of marsh unless enforcement is strengthened. Development outside the marsh would continue to depend on land availability/general economic climate. Transportation projects (extension of MBTA rail line to Lynn, building of B&M rail station, Revere Connector Highway) may impact the marsh. Small increase in navigation in Saugus/Pines Rivers, moderate in Lynn Harbor. Improved recreational facilities; Revere Beach facilities upgraded and beach nourished by the Corps. No change in noise levels; small decrease in air quality due to development.	No induced development in the marsh or the floodplain. Flood damages reduced for about 3950 buildings; reduced flooding of the MBTA Blue Line and Route 1A, as well as on local streets behind the LPP structures. Access to waterfront for navigation interests would be provided through the LPP structures. Recreational access to the marsh and rivers would be reduced by the LPPs, but important access points provided. Corps would participate in recreational development of MDC Park DiKE at Revere Beach. Temporary traffic, noise and dust impacts and public access restrictions to construction sites during construction. Some waterfront access inconvenience to navigation interests during construction.	No induced development. Flood protection for about 240 buildings. Temporary, localized traffic, noise and dust impacts during construction.	No induced development in the marsh or the floodplain. Flood damages reduced for about 5000 buildings; reduced flooding of all major transportation arteries serving the Study Area and Boston's north shore and local streets inside the floodgates and behind shorefront structures. No significant velocity impacts at open navigation gate. Vessel fleet in Saugus/Pines Rivers would be protected during storms. Minimal impacts to recreational access. Corps would upgrade Pt. of Pines dune/beach area and participate in recreational development of MDC Park DiKE at Revere Beach. Temporary traffic, noise and dust impacts and public access restrictions to construction sites during construction. No significant navigation impacts during construction.

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Visual Resources	Strong visual contrasts in a heavily urbanized setting, thanks to 1660 acre estuary, coastal shorefront and the open water of Lynn Harbor and Broad Sound.	Revitalization of the built environment should enhance the visual quality of the area. Impacts from development possible throughout the Study Area.	Views blocked for a significant number of residents behind LPP structures. Aesthetic impact of 8.8 miles of LPP structures.	No significant impact.	Views blocked by project structures, including the floodgate, for about 15-20 residences at Pt. of Pines. Aesthetic impact of 3.5 miles of project structures.
Historic and Archaeological Resources	Presence of historic and prehistoric sites.	Potential impact on well-preserved buried sites with future transportation development in the estuary.	Potential impact on undiscovered buried resources, particularly along Saugus & Pines Rivers.	No Impact.	No Impact.
Mitigation	N/A	N/A	Creating intertidal habitat and transplanting of clams in the I-95 fill site mitigation area (14.8 acres); marsh planting (19.5 acres).	None	Creating intertidal habitat and transplanting of clams in the I-95 fill site mitigation area (2.0 acres); create (1.0 acre) sub-tidal habitat; marsh planting (fringe of mitigation site).

<u>Resource</u>	<u>Base Condition</u>	<u>Without Project Condition (No Action)</u>	<u>Option 1 Four LPPs</u>	<u>Option 2 Nonstructural</u>	<u>Option 3 (NED Plan) Regional Floodgate Plan</u>
Mitigation Costs	N/A	N/A	\$1,200,000 (benthic/wetlands)	N/A	\$200,000 (benthic)
Study Area Economics (1988 Price Level)	Commercial, industrial and residential uses.	Average annual damages approx. \$12.6 Million.	Project First Cost \$62.4 M Avg. Annual Costs \$5.98 M Avg. Annual Benefits \$7.16 M Net Benefits \$1.18 M Benefit-Cost Ratio 1.2	Project First Cost \$7.4 M Avg. Annual Costs \$0.7 M Avg. Annual Benefits \$10.96 M Net Benefits \$2.32 M Benefit-Cost Ratio 1.3	

- Notes: 1. Base condition year - 1992
 2. Period of Analysis - 100 years
 3. B/C Ratio - Avg. Annual Benefits/Avg. Annual Costs
 4. N/A - Not Applicable

6.0 Affected Environment

A. Introduction

Existing Conditions

6.01 The Study Area comprises four communities along the northeastern coast of Massachusetts: Lynn, Malden, Revere and Saugus. Physically, this area is drained by the Saugus and Pines Rivers which meet and form a 1660 acre estuary fully contained within the Study Area. The rivers empty at the mouth of the Saugus River into Broad Sound and Lynn Harbor, contiguous to Massachusetts Bay and the Atlantic Ocean. (See Figure 6.1.) The estuary, containing approximately 1070 acres of vegetated wetlands, comprises the largest wetland area located in close proximity (about ten miles) to downtown Boston. It is an ecologically diverse environment containing a large landfill and waste incineration plant at its center. It is traversed by a major highway, a commuter rail line and the abandoned I-95 embankment. Surrounding the estuary area are well developed residential, commercial and industrial components of the four communities. A large area along the Saugus River in Lynn is occupied by the General Electric Plant, a defense-related industry. The shorefront in the Study Area is in Revere and Lynn. Recreationally important Revere Beach forms a substantial portion of the shoreline. Approximately three hundred fifty vessels find a home in the Saugus and Pines River. Several hundred more moor in Lynn Harbor.

Future Without Project Conditions

6.02 Significant condominium development has taken place along the upland portions of Revere Beach and Lynn's Inner Harbor in recent years, and is expected to continue. The mostly undeveloped Lynn South Harbor shorefront is expecting to see similar activity in the near future as is the Revere side of the Saugus River just upstream of the General Edwards Bridge. Three transportation projects are planned for the estuary. Additional future without project conditions include dredging of the Saugus River and possible dredging of the Pines River, capping of the Saugus landfill and elimination of the Lynn combined sewer overflow (CSO) - leading to improved water quality, restoration of Revere Beach with sand from the I-95 embankment and protection of Roughans Point with revetments. Illegal wetland filling would doubtless continue and raising of riverbank protection around the estuary to keep pace with sea level rise.

Significant Resources

6.03 Significant resources documented throughout the Study Area include the tidal hydrology itself, water quality, wetlands, benthic habitats, sandy beaches, artificial shorelines, fish, lobsters, wildlife, rare, threatened and endangered species, socioeconomic resources, visual resources and historic and archaeological resources.

6.04 Significant resources in the Saugus and Pines Rivers Estuary, along Lynn Harbor and the Revere Beach and Point of Pines shorelands can be classified as

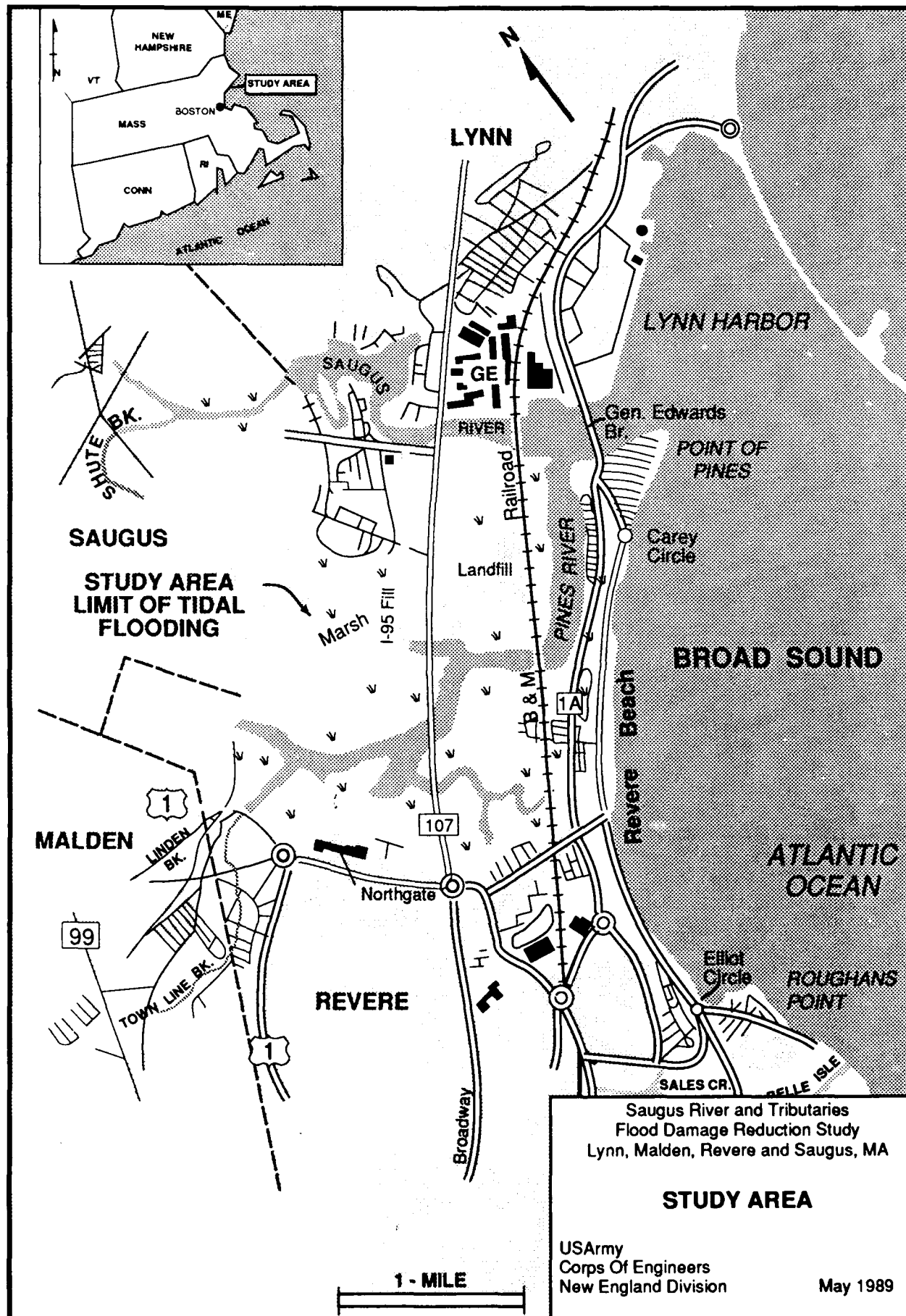


Figure 6.1

National Economic Development (NED) resources and Environmental Quality (EQ) resources. The NED resources in the Study Area include commercially and recreationally harvested species of finfish and shellfish. The EQ resources of the Study Area include ecological resources, e.g. wetlands, intertidal and subtidal habitats, cultural resources (historic and prehistoric sites) and visual resources. The quantity and quality of EQ resources directly affects NED resources and the human use of the system.

6.05 The significance of a resource affected by a project is based upon its institutional status, technical or scientific merit, public merit or institutional standard. Federal laws and coordination along with State law and public opinion have been used to define significant resources. The resources of the Study Area have been identified in detail and those that were deemed significant are discussed in this section.

6.06 The Commonwealth of Massachusetts provides institutional significance through its identification of significant natural resources under various acts, but in particular M.G.L. Chapter 131 S. 40, The Wetlands Protection Act. Throughout the Study Area this Act provides regulations for all wetlands. These regulations define the significant features of Land Under the Ocean (310 CMR 10.25); Coastal Beaches (310 CMR 10.27); Coastal Dunes (310 CMR 10.28); Barrier Beaches (310 CMR 10.29); Coastal Banks (310 CMR 10.30); Rocky Intertidal Shores (310 CMR 10.31); Salt Marshes (310 CMR 10.32); Lands Containing Shellfish (310 CMR 10.34); Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie Anadromous/Catadromous Fish Runs (310 CMR 10.35); and Rare Species (310 CMR 10.37). Various other State laws affect the status of resources, but in particular the 1988 designation of the Study Area as a State "Area of Critical Environmental Concern" under the Massachusetts Coastal Zone Management program reflects the public view of all the ecological resources in the Study Area as significant. Local opinion through their participation in the study, has expressed significant concerns for all the natural resources of the system, but in particular for the wetlands, waterfowl and finfish of the estuary. As part of the ACEC designation, the Saugus and Pines River Estuary would be protected under the Coastal Wetlands Restriction Act. Under this Act a permanent Restriction Order for the properties on site would be recorded at the Registry of Deeds in Essex and Suffolk counties. This would help to restrict activities in these wetlands by giving notice of the restriction to future purchasers (DEQE, 1984).

6.07 All Federal standards, e.g. National Historic Preservation Act; Executive Order 11990-Protection of Wetlands; The Endangered Species Act; and EPA Quality Criteria for Water have been given consideration in developing significance of particular resources. Additionally, Section 122, 1970 River and Harbor Act, P.L. 91-611 identifies significant resources. Under this law consideration must be given to the potential significance of economic, social and environmental resources of the region. The significance of air, noise and water pollution, destruction of resources, aesthetic values, community cohesion, public facilities and services, employment, tax and property value, potential displacement of people, businesses and farms and potential disruption of desirable community and regional growth have been reviewed.

Figure 6.1 is an overview of the Study Area. Additional maps and extensive discussions of each resource topic can be found in the Environmental and Socioeconomic Appendices to this report and in the references cited throughout this EIS/EIR. Also, further backup information is available in the Hydrology and Hydraulics, and Water Quality Appendices.

B. Hydrology and Hydraulics

6.08 The significant resources of the Study Area are dependent on the tidal processes of the system. The interaction of tidal flows with the physical shorefront and estuarine basin structures the resources.

Astronomical Tide Levels

a. General

6.09 Tides in the area are semidiurnal, with two high and two low waters occurring during each lunar day (approximately 24 hours 50 minutes). The resulting tide range is constantly varying in response to the relative positions of the earth, moon and sun, the moon having the primary tide-producing effect. At the National Ocean Survey (NOS) tide gage in Boston, Massachusetts (less than 10 miles from the Study Area), the mean range of tide and the mean spring range of tide are 9.5 and 11.0 feet, respectively (see Table 6.1). However, the maximum and minimum predicted astronomic tide ranges at Boston have been estimated at about 14.6 and 5.1 feet.

b. At the Study Area

6.10 In general, tide levels at the mouth of the Saugus River are found nearly identical to those at Boston. Tide levels in the estuary show some variance in height and timing from those at the mouth of the Saugus River. It was determined from measurements taken within the estuary, that for normal nonstorm tide conditions, the smaller the tide range, the less change there is in tide heights and timing as one proceeds upstream from the river's mouth. Mean tide range produces nearly the same elevations and timing inland as at the coast. For spring tides, the high tide tends to be lower (0.1-0.5 feet) and later (5 to 50 minutes) inland and the low tide tends to be higher and later inland, than at the mouth of the Saugus River. On the upper Saugus River portion of the estuary the change seems to be due mostly to frictional impacts of the channel. For the upper Pines River portion of the estuary, however, the reduction in elevation is related mostly to the restrictive channel opening at the abandoned I-95 embankment and the relatively large storage available in the marsh. Larger differences occur at low water than at high water. Further information is provided in the Hydrology and Hydraulics Appendix.

TABLE 6.1

BOSTON TIDAL DATUM PLANES
NATIONAL OCEAN SURVEY TIDE GAGE
(BASED UPON 1960-78 NOS TIDAL EPOCH)

	<u>Tide Level</u> (Ft. NGVD)
Maximum Predicted Astronomical High Water	7.5
Mean Spring High Water	5.8
Mean High Water (MHW)	5.0
Minimum Predicted Astronomical High Water	2.7
Mean Tide Level (MTL)	0.3
National Geodetic Vertical Datum (NGVD)	0.0
Maximum Predicted Astronomical Low Water	-2.4
Mean Low Water (MLW)	-4.5
Mean Spring Low Water (MLWS)	-5.2
Minimum Predicted Astronomical Low Water	-7.1

Storm Tides

a. General

6.11 The combined effect of astronomical tide and storm surge produced by wind, wave and atmospheric pressure contributions is reflected in actual tide gage measurements. Since the astronomic tide range at the project is so variable, many severe coastal storms occur during periods of relatively low astronomic tides. Thus, even though a storm may produce exceptionally high onshore winds, waves and a tidal surge, the resulting tide level may be less than that occurring during a time of high astronomic tide and no meteorological influence. Figure 6.2 presents a tide stage-frequency relationship for the Boston NOS gage which was developed using historic annual maximum still-water levels. Table 6.2 lists maximum annual storm surges determined by the National Weather Service in their "Tide Climatology For Boston, MA," (November, 1982) and associated observed tide levels at Boston. The recurrence intervals of the maximum observed tide levels recorded on days of maximum annual storm surge were generally less than one year, with only a few storms producing significant tidal flood levels. Some of the most severe onshore winds, waves, and storm surges are shown to have produced minor tidal flooding, owing to their coincidence with low astronomic tides. A good example of this is the November 30, 1945 event which produced the maximum storm surge of record at Boston of 4.9 feet; extremely high onshore winds occurred during low astronomic tide and resulted in only a minor tidal flood level (7.6 feet NGVD).

6.12 Conversely, rather significant tidal flood levels can result from the coincidence of relatively high astronomic tides and only minor meteorological events. Astronomic high tide level in Boston alone can reach 7.5 feet NGVD (see Table 6.1). With such a condition, a coincident storm surge of only 2 to 3 feet can produce major tidal flood levels. The 7 February 1978 storm tide at Boston reached 10.3 feet NGVD, the greatest of record, but was produced by a combination astronomic tide of 6.9 feet NGVD and surge of 3.4 feet, the latter being of only moderate magnitude (see Table 6.2 which shows that a surge of 3.4 feet is not extreme). The Study Area obtains its damaging tide levels during the late fall, winter and early spring months, from extra-tropical "northeasters". Tropical cyclonal events historically have not produced significant tide levels at this coastal area.

b. At the Study Area

6.13 Studies by the Coastal Engineering Research Center (CERC) for the adjacent Roughans Point Project have indicated that storm tide frequency in the Saugus and Pines Rivers system is nearly identical to that at the Boston NOS gage. The interior flood levels developed were at least equal to the stage-frequency curve at Boston (Figure 6.2) and in some cases a few tenths of a foot higher because of the effect of the wind within the estuary. Based on Figure 6.2, the peak storm tide stillwater elevations at the mouth of the Saugus River for the 1 percent (100-year), 2 percent (50-year) and 10 percent (10-year) chance flood events are 10.3, 10.0 and 9.1 feet NGVD, respectively. In addition, Corps criteria calls for analysis of a standard project storm for

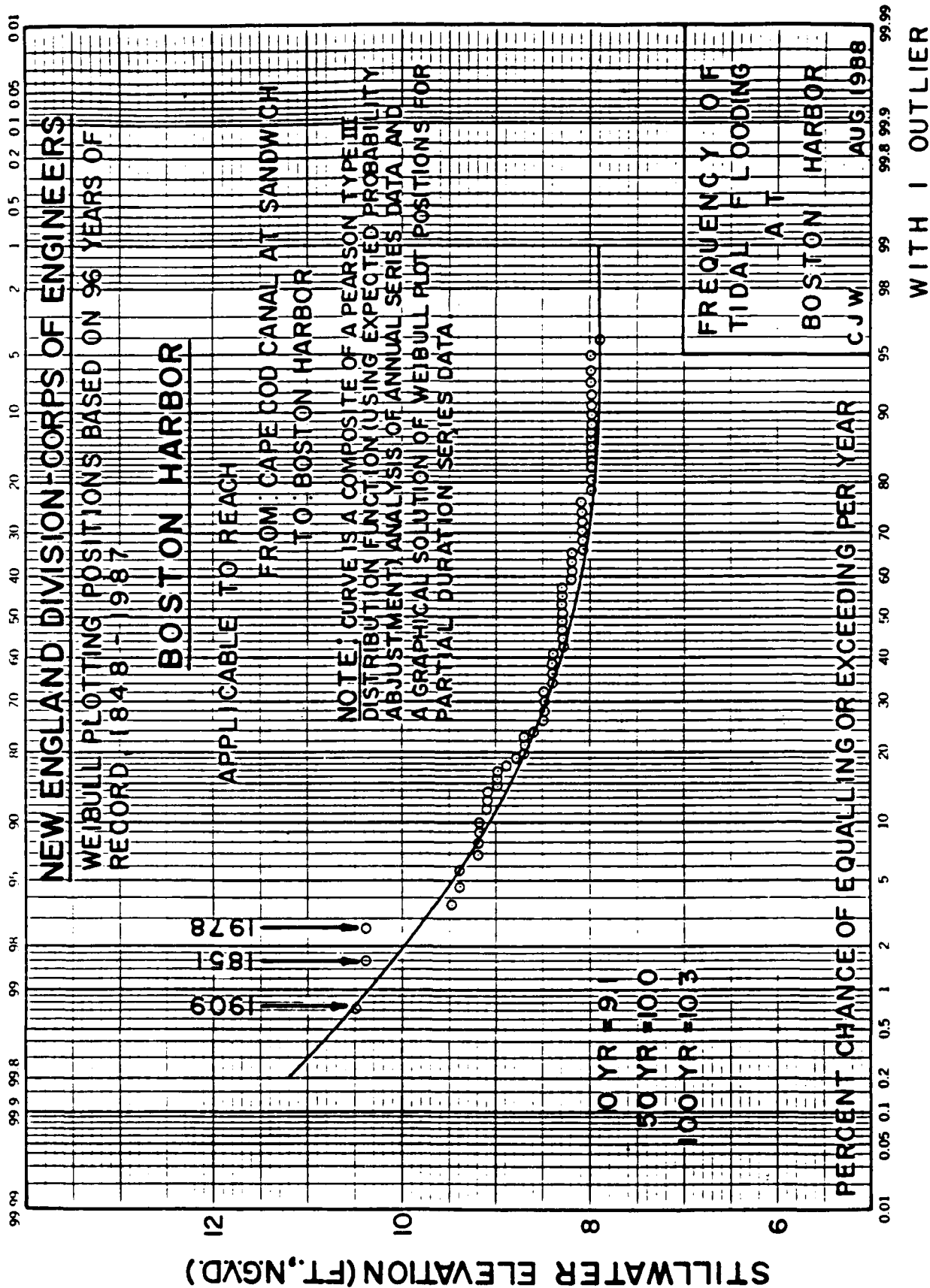


Figure 6.2

TABLE 6.2

ANNUAL MAXIMUM STORM SURGE
BOSTON, MASSACHUSETTS
(1922-1979)

Date	Annual Maximum Storm Surge (feet)	Maximum Observed Tide Level for the Day (feet, NGVD)	Recurrence* Interval (years)
30 Nov 1945	4.9	7.6	LT 1
13 Apr 1961	4.7	8.0	1
6 Feb 1978	4.6	10.0	50
14 Feb 1940	4.2	5.0	LT 1
17 Nov 1935	4.1	6.5	LT 1
19 Feb 1972	4.0	9.1	10
3 Mar 1947	3.8	7.2	LT 1
4 Mar 1960	3.8	8.1	2
30 Jan 1966	3.8	5.5	LT 1
12 Nov 1968	3.7	7.7	LT 1
25 Jan 1979	3.7	9.2	13
22 Mar 1977	3.6	5.3	LT 1
25 Nov 1950	3.6	6.4	LT 1
31 Aug 1954	3.5	8.2	2
16 Feb 1958	3.5	7.9	1
15 Nov 1962	3.5	7.9	1
16 Mar 1956	3.4	5.6	LT 1
27 Dec 1969	3.3	6.7	LT 1
11 Mar 1924	3.2	6.2	LT 1
31 Jan 1939	3.2	6.9	LT 1
18 Feb 1952	3.2	7.9	1
7 Mar 1923	3.1	6.9	LT 1
20 Feb 1927	3.1	6.9	LT 1
19 Jan 1936	3.1	5.9	LT 1
7 Nov 1953	3.0	7.4	LT 1
14 Aug 1971	3.0	5.4	LT 1
29 Jan 1973	3.0	6.1	LT 1
12 Mar 1959	2.9	6.5	LT 1
16 Apr 1929	2.8	6.6	LT 1
8 Mar 1931	2.8	6.5	LT 1

*Recurrence interval of observed tide elevations. Obtained from tide stage-frequency relationship, Figure 6.2.

NOTE: LT = Less Than.

the Study Area as discussed in EM 1110-2-1411. The standard project storm for this project, which is called the Standard Project Northeaster (SPN), is the "most severe combination of meteorologic and tidal conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations." The SPN stillwater level for this study has been determined to be 12 feet NGVD.

Future Without Project Conditions

6.14 Without the proposed Federal Project the future condition would be expected to include higher sea levels. It is noted that historically sea level has been rising at a rate of about 0.1 foot per decade and accelerated rates of up to four feet during the next century have been predicted. Projecting rising sea levels at this 0.1 foot per decade rate for the next 100 years would indicate that concurrent increases should be expected in tidal frequency elevations and the calculated SPN level.

C. Water Quality

General

6.15 The inland waters of the Saugus and Pines Rivers have been designated class B and the coastal waters of these rivers have been designated class SB by the Massachusetts Division of Water Pollution Control (MDWPC). Class B waters are suitable for swimming, other recreation and for protection and propagation of fish, other aquatic life and wildlife. Class SB waters, in addition to those designated uses as described for class B waters, are suitable for shellfish harvesting with depuration. Shellfishing is the most sensitive activity in the coastal area due to the stringent controls established to prevent human consumption of contaminated clams and other bivalves. Designation of the Saugus and Pines River Estuary as part of an ACEC requires that the Division of Water Pollution Control classify the waters as SA and incorporate strict antidegradation standards. The goal of this requirement is eliminate discharges of hazardous substances, new industrial discharges and direct discharges from new sewage treatment facilities. Class SA waters are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting without depuration in approved areas (314 CMR 4.00).

6.16 According to the "Saugus River Basin Water Quality Survey" prepared by the MDWPC in November, 1982, water quality in the Saugus and Pines Rivers Estuary generally meets class standards during dry weather flow with a few minor violations occurring from high coliform counts caused by combined sewers, illegal sewer connections, and failing septic systems. During storm events, however, discharges from storm drains and overland flow have a significant adverse impact on water quality in the upper estuary (above the Route 107 bridge) principally because these discharges make up a larger percentage of the water volume during these events. Dissolved oxygen levels are impacted by the high quantities of BOD discharged. Coliform levels are also extremely high. In the lower estuary (below the Route 107 bridge), the

BOD levels do not have as severe an impact due to the greater volume of water involved in the tidal interchange. However, coliform levels are high enough that during low tides standards are consistently exceeded even in the downstream area during high runoff events. Because of the high coliform levels in the estuary, the mudflats within the estuary have not been classified open for shellfishing in recent years, although a few areas have been classified as restricted, whereby licensed Master Diggers and their employees may harvest shellfish and then have them depurated at the shellfish purification plant in Newburyport, MA.

6.17 Results of the 1982 MDWPC testing for cadmium, chromium, mercury, and zinc show that concentrations in the lower estuary, downstream from the Route 107 bridges, generally meet the latest Water Quality Criteria (1986) established by EPA. Results of sampling by the Corps at various times from 1982 to 1986, however, show some problems with a number of heavy metals.

Major Pollution Sources

6.18 There have been several pollution sources identified within the estuary: three thermal water discharges - General Electric River Works Plant (31 discharge locations), RESCO Plant and Eastern Tool Manufacturing Company (one pipe each); one intermittent discharge from Lynn's combined sewer overflow; and one leachate from the Saugus landfill.

6.19 Permitted thermal discharges allowed to the three companies amount to over 160 million gallons/day (mgd), although the most that would generally be discharged concurrently would be less than 100 mgd (115 cfs). The locations of all discharges, except Eastern Tool Company's, are between Route 107 and the General Edwards Bridge on the Saugus River.

6.20 The combined sewer overflow (CSO) at Summer Street in Lynn discharges an estimated 40 to 50 times a year into the Saugus River during times when rainfall intensity is more than 0.1 inch/hr. Annual loadings estimated for the Lynn CSO include: Flow - 160 million gallons/year, BOD - 95,000 pounds (lb)/year, Total Solids - 467,000 lb/year, Total Kjeldahl Nitrogen - 19,000 lb/year, Ammonia Nitrogen - 6,000 lb/year and Phosphorus - 4,000 lb/year. The Lynn Water and Sewer Commission has engaged a consultant to correct the problem. Preliminary plans call for removing the CSO from the Saugus River through separation of sewers.

Water Quality Parameters

6.21 Unless otherwise noted all data in the following sections pertains to the estuary of the Saugus and Pines Rivers.

a. Water Temperature

6.22 Since tidal movement dominates the water flow within the estuary, water temperatures are generally the same as the ocean temperatures which exist in Broad Sound. Temperatures in Broad Sound generally range from the low 30's

during mid winter to the low to mid 70's during late summer. The releases made from the industries along the lower Saugus River, as described in their National Pollutant Discharge Elimination System (NPDES) Permits, are small in comparison to the natural tidal flushing volume, and temperature rise in the farfield areas is negligible. From analysis completed by General Electric and RESCO as part of their Permit requirements, temperatures reduce to less than 2° Fahrenheit change less than a few hundred feet from the point of discharge.

b. Salinity

6.23 As a result of the sluggish flow from the large upstream wetlands and ponding areas, the freshwater volume entering the tidally influenced portion of the Saugus and Pines Rivers is a small component of the estuarine volume.

6.24 From water quality data collected within the estuary by the Corps of Engineers, and by RESCO as part of their NPDES Permit requirement, there appears to be nearly complete top to bottom mixing of salinity with freshwater from the mouth of the Saugus River up to the Lincoln Avenue bridge and from the mouth of the Pines River to its upper end at the Town Line Brook tide gate. Further upstream on the Saugus River, minor density stratification does occur. The upper limit of salinity is at the Saugus Iron Works historical site northern boundary line on the Saugus River, the Central Street Bridge on Shute Brook and the Town Line Brook tide gate on the Pines River. The highest salinity levels occur at the mouth of the Saugus River, ranging from 29 to 33 ppt.

c. Dissolved Oxygen

6.25 Dissolved oxygen (DO) levels were measured in the estuary during low and high tide conditions by the Corps in 1986 and by the MDWPC in 1982. The results generally show that during extreme low tide conditions there is a low DO problem in the Saugus and Pines Rivers above Route 107. During high tide measurements, most areas meet the minimum 6 mg/l State criteria with the exception of the upper Pines River and upper Diamond Creek area.

d. pH

6.26 According to the 1986 Corps data, those areas inundated by large amounts of saltwater have high pH, generally above 7, and rising as high as 8 standard units (SU). Low pH levels, slightly below the State criteria of 6.5 SU, occur in the freshwater-dominated upper areas of the Saugus and Pines Rivers and in the small streams that drain into the estuary during times of low tide. The low pH is due primarily to natural processes since there are no major industrial discharges in the upper basin.

e. Turbidity and Apparent Color

6.27 Turbidity values measured by the Corps in 1986 throughout the estuary were low, ranging from 0.8 to 4 Jackson Turbidity Units (JTU). Apparent color

levels show significantly more variation ranging from five standard units (SU) up to 40 SU; the highest levels occur in the upper estuary during dead low tide when the water column is almost entirely freshwater.

f. Suspended Solids

6.28 According to the 1986 Corps data, suspended solids content within the water column is low throughout the tide cycle with values ranging from 7 to 31 mg/l. Solids concentrations averaged 13 mg/l and the volatile portion averaged about 3 mg/l. There was no significant variation from top to bottom within the estuary indicating that there was only a minor amount of suspended sediment moving along the bottom. The largest difference between the surface and bottom values occurred near the General Edwards Bridge where the constriction caused by bridge piers resulted in higher velocities and more suspended solids moving near the bottom of the channel.

g. Nutrients

6.29 Data collected in 1986 by the Corps in the estuary indicates that phosphorous levels ranged from 0.03 mg/l to 0.15 mg/l, nitrate/nitrite levels ranged from 0.045 mg/l to 0.75 mg/l and ammonia levels ranged from 0.04 mg/l to 0.61 mg/l. The higher concentrations occurred at low tide at the upper ends of the estuary.

h. Biological Oxygen Demand (BOD)

6.30 Analysis of samples collected during dry weather conditions indicate that there are only minor amounts of BOD present in the water column (less than 2 mg/l). More significant amounts have been recorded during wet weather conditions by the MDWPC and by Camp, Dresser and McKee as a result of storm drainage and combined sewer discharges.

Contaminants

a. Metals

6.31 Grab water column samples have been collected at various times by the Corps of Engineers during the period 1982-1986. The results showed that there were a number of metals exceeding EPA's chronic criteria to protect sensitive marine aquatic life although the less stringent acute criteria were usually met. Mercury appears to exceed the chronic criteria frequently while other metals showing occasional exceedances include copper, zinc, lead, chromium and nickel. Acute criteria is also occasionally exceeded by copper.

b. Oil and Grease

6.32 In general, the levels of oil and grease throughout the Study Area are low, less than 1 mg/l, with 12 mg/l at a maximum.

c. Coliform Bacteria

6.33 The highest coliform bacteria levels occur during wet weather conditions as storm drains, combined sewer overflows and overland flow cause exceedances of State saltwater criteria throughout the estuary.

6.34 Dry weather flow measurements taken by the Corps on August 20, 1986 show that coliform levels which cause minor exceedances of State saltwater criteria generally occur at the upper ends of the tidally influenced portions of the water body during a low tide condition. It appears, as suggested by the MDWPC, that direct sewage overflows or defective septic systems are draining into Shute Brook, upper Diamond Creek, Town Line Brook and possibly the Saugus River above the Lincoln Avenue bridge. From analysis of the Corps data, values throughout the estuary ranged from 30 to 11,000 colonies/100 ml for total coliform and from 2 to 1,100 colonies/100 ml for fecal coliform. During high tides, coliform levels are diluted significantly such that State saltwater criteria were met at almost all stations during the Corps measurements.

Future Without Project Conditions

6.35 A number of construction projects are expected to take place within the next few years, with several having a significant impact on the water quality within the Basin. Improvements to the estuary will take place with the anticipated elimination of Lynn's combined sewer overflow and the complete capping of the Saugus Landfill, both projects removing major sources of pollutants (i.e. bacteria, organics, heavy metals). Sea level rise and other projects would result in an increase in the tidal flushing of the estuary. They include the construction of the Saugus River Navigation Project which consists of dredging portions of the Saugus River. Increased flushing will result in increased sediment movement (including contaminants) out of the estuary into Broad Sound, increased dilution of pollutants in the estuary and an overall increase in dissolved oxygen levels in the estuary. Similar results would occur if dredging of the Pines River were to take place. Transportation improvements in the estuary could lead to increased contaminant loads. Long term development of the Saugus River Basin will cause increased nutrient and heavy metals concentrations in the estuary as the runoff characteristics of the basin are changed. Increased recreational boating in the Saugus and Pines Rivers would also cause some deterioration of water quality in the estuary.

D. Estuarine and Coastal Resources - Introduction

6.36 The Study Area is an estuarine and coastal system which is dominated by tidal habitat for NED (shellfish and finfish) resources and a significant wetland of high ecological value as an Environmental Quality resource. Within the Study Area inland (west) of the General Edwards Bridge, estuarine habitat types include deepwater habitat (i.e. below the elevation of extreme low water of spring tide), subtidal unconsolidated bottom and aquatic bed habitats, and intertidal aquatic bed, unconsolidated shore and emergent wetland habitats

(Cowardin et al., 1979). The latter class, with the dominance type of salt-meadow grass (*Spartina patens*) is by far the most extensive community type within the wetlands of the Study Area.

E. Wetlands

General

6.37 There are approximately 1,070 acres of vegetated wetland within the approximately 1,660 acre Saugus and Pines Rivers Estuary (including Shute Brook). This vegetated wetland is predominantly made up of irregularly flooded (flooded less often than daily) high salt marsh (803 acres) which is typical of salt marshes of the Northeast. Regularly flooded (flooded twice a day) low salt marsh makes up 115 acres of the total, occurring mostly along the borders of the saline rivers and creeks which bring water to the marsh. Areas at the inland extremes of the marsh are dominated by brackish and fresh water emergent vegetation such as cattails (*Typha* spp.) and common reed (*Phragmites australis*). They make up 152 acres of the total vegetated wetland. A majority of the areas dominated by common reed are located in pockets of what was once salt marsh. The construction of roads and the I-95 roadbed severely restricted tidal flow to these areas creating conditions suitable for the growth of the less desirable common reed. Seasonally flooded wooded and shrub swamp are present in areas transitional between marsh and upland.

6.38 Wetlands are generally credited with having functions and values which vary with the wetland type, size and location. Some of the major values ascribed to wetlands to a greater or lesser degree are outlined by Tiner (1984). These include: wildlife habitat, fish and shellfish habitat, water quality maintenance, aquatic productivity enhancement, flood and erosion control, recreational and educational opportunities, aesthetic qualities, and production of consumable products. The Saugus and Pines Rivers wetlands provide all of the above technical values which, along with their institutional status, contribute to their significance as an EQ resource.

Salt Marsh

6.39 Salt marshes are divided into two types based on the frequency of tidal flooding: low marsh and high marsh. Low marsh or regularly flooded salt marsh extends to roughly the level of mean high water (MHW) and is therefore flooded twice each day in New England. High marsh extends from the inland limit of low marsh to the level of the highest lunar tides (Lefor, 1987). Salt marsh of the Saugus/Pines wetland is predominantly high marsh.

6.40 High marsh vegetation in New England is typically dominated by salt-meadow grass (*Spartina patens*) as it is in the Study Area high marsh. Nixon (1982) described the upland to bay open water vegetation sequence developed by Miller and Egler (1950) as "probably the most useful general model of vegetation on the New England salt marshes...their general upland-to-bay sequence consisted of a *Panicum virgatum* Upper Border, a *Juncus gerardii* Upper Slope, a *Spartina patens* Lower Slope, and a *Spartina alterniflora* Lower Border."

6.41 The above is a very simplified marsh profile. Salt marshes typically support a number of other species of vegetation, most notably spike grass (Distichlis spicata) which often makes up a large portion of the high marsh vegetation as it does west of the I-95 embankment in the Study Area. A more detailed generalized marsh profile was prepared by Niering and Warren (1980) (see Figure K8 in Environmental Appendix). The Study Area salt marsh is more reflective of this varied profile which shows that the gradation from open water to upland is often interrupted by mosquito ditches, pannes, pools, and mounds or levees. Marsh elder (Iva frutescens) is often present along the upland border between the switchgrass (Panicum virgatum) and blackgrass (Juncus gerardii) zones and on levees along mosquito ditches. A number of forbs such as sea lavender (Limonium carolinianum) and seaside goldenrod (Solidago sempervirens) are also present on the high marsh, often associated with bare patches (Bertnes and Ellison, 1987). Areas of restricted drainage often support the short form of saltmarsh cordgrass (Spartina alterniflora) and slender glasswort (Salicornia europea). This pattern of vegetation on the high salt marsh is dependent on a number of changeable physical and biotic factors, and plant species composition may change significantly over a period of time (Nixon, 1982).

6.42 The low marsh supports a much smaller variety of plants, almost always dominated by saltmarsh cordgrass (Spartina alterniflora). Some of the high marsh forbs and glassworts may be found on the low marsh but their abundance is very limited.

Tidal Freshwater/Brackish Marsh

6.43 Odum et al., (1984) in "The Ecology of Tidal Freshwater Marshes of the United States East Coast: A Community Profile" define tidal freshwater wetlands as those wetlands "located upstream from tidal saline wetlands and downstream from nontidal freshwater wetlands and characterized by (1) near freshwater conditions (average annual salinity of 0.5 ppt or below except during periods of extended drought), (2) plant and animal communities dominated by freshwater species, and (3) a daily, lunar tidal fluctuation." They are dominated by a large and diverse group of broad-leafed plants, grasses, rushes, shrubs, and herbaceous plants in contrast to salt marshes which are dominated by estuarine marsh grasses (Spartina spp.) (Odum et al., 1984).

6.44 Odum et al., (1984) developed a classification of eight major floristic associations in tidal freshwater wetlands. Of these eight, two are found in the Saugus/Pines Rivers system: Cattail Community Type and Mixed Aquatic Community Type.

6.44A The Cattail Community Type is the more common in the Study Area. It is described as occurring in dense monospecific stands or with one or more associates and occurs with common reed (Phragmites australis) in disturbed areas (Odum et al., 1984). All of these compositional types are present in the Study Area.

6.45 The more varied Mixed Aquatic Community Type consists of an extremely variable mix of freshwater marsh vegetation and occurs in the upper intertidal zone of the marsh (Odum et al., 1984). Species listed as common to this community type and present in the Study Area marsh are arrow-arum, rose mallow, smartweeds, cattails, purple loosestrife and jewelweed. A small area of this type is present just north of Hamilton Street in Saugus. Saltmeadow grass (Spartina patens) and saltmarsh cordgrass (Spartina alterniflora) are also present in this area.

6.46 Zonation in freshwater tidal marshes is less distinct than in salt marshes but does occur. Metzler and Rozza (1982) (Odum et al., 1984) describe 5 zones (SUBTIDAL, LOWER INTERTIDAL, MID-TIDAL MARSH BORDER, HIGH MARSH, UPLAND) in a Connecticut tidal freshwater marsh. Factors controlling plant species distribution are the frequency and duration of flooding, substrate characteristics, current flow, salinity, physiological capability to exist with anaerobic toxins, interspecific competition and allelopathy (the suppression of growth of one plant species by another due to the release of toxic substances). The upper limit of tidal freshwater marshes is typically at the mean high water line where shrub and forest vegetation begin to dominate. Slopes are greatest in the Subtidal and Lower Intertidal zones. The elevation continues to increase in the relatively narrow Mid-tidal Marsh Border zone, then decreases forming a slight levee. The elevation then gently increases through the High Marsh zone to the upland edge (Odum et al., 1984).

Description of Community Types

6.47 The community types defined and delineated for the cover maps of the Study Area (presented in the Environmental Appendix) primarily reflect the hydrologic regime and vegetative species composition which dominate within each unit. As outlined in Table 6.3, the initial classification relates to the water regime of the wetland as defined by Cowardin et al. (1979). Tidal wetland portions of the Study Area are discussed as follows:

- . subtidal (permanently flooded with tidal water);
- . irregularly exposed (land surface is exposed by tides less often than daily);
- . regularly flooded (tidal water alternately floods and exposes the land surface at least once daily);
- . irregularly flooded (tidal water floods the land surface less often than daily); or
- . seasonally flooded freshwater.

6.48 Possible exceptions to the estuarine classifications are the very upper reaches of the Saugus River and Shute Brook within the Study Area; in-channel salinity readings during late summer low tides (<0.5 ppt) indicate these reaches to be more appropriately classified as riverine permanently flooded-tidal zones, although the adjacent marshes having higher interstitial salinities are primarily considered to be estuarine.

Table 6.3 Wetland Community Types Delineated Within the Study Area

SUBTIDAL HABITATS

TR: Tidal River
PND: Pond (in part)

IRREGULARLY EXPOSED HABITATS

MF: Intertidal Flat (in part)
CR: Creek
PND: Pond (in part)

REGULARLY FLOODED HABITATS

SAT: Spartina alterniflora, tall form (>0.8m), dominates
MF: Intertidal Flat (in part)

IRREGULARLY FLOODED HABITATS

HM: High Marsh, undifferentiated
SP: Spartina patens dominates
SP/DS: Spartina patens, Distichlis spicata, near equal dominance
DS: Distichlis spicata dominates
JG: Juncus gerardii dominates
SAS: Spartina alterniflora, short form (<0.3m), dominates
SAM: Spartina alterniflora, mid-height (0.3m-0.8m), dominates
IF: Iva frutescens dominates
TY: Typha spp. dominates
PH: Phragmites australis dominates
LY: Lythrum salicaria dominates
BM: Brackish Marsh (mixed composition)
PAN: Panne
NV: Non-vegetated

SEASONALLY FLOODED FRESHWATER HABITATS

SS: Shrub Swamp
WS: Wooded Swamp

UPL: UPLAND

6.49 Within the regularly flooded and irregularly flooded zones, the dominant vegetative species have been delineated on the cover maps to the extent possible. In places, particularly in the irregularly flooded marsh, species interspersions are so varied that no single dominance type can be delineated at this scale. When these undifferentiated types cover large areas they have been classified as undifferentiated high salt marsh, otherwise they have been incorporated into the surrounding cover type. Tables 6.4 through 6.6 summarize pertinent information from the cover maps, for the estuarine portion of the Study Area. Brief descriptions of the various community types delineated on the cover maps and acreages for the estuary are discussed below:

a. Subtidal Habitats

6.50 Subtidal zones, or areas where the substrate is permanently flooded with tidal water, have been labeled primarily as "TR" (for tidal river). These include the Saugus and Pines Rivers proper, Diamond Creek, Shute Brook, and major tributary channels to these waterways. An attempt has been made to differentiate these from smaller creeks which may periodically become exposed during extreme low spring tides. Permanently flooded ponds ("PND") are also included within this water regime, although they are often situated in intertidal marshes. The submergent widgeon grass (Ruppia maritima) was frequently observed in such ponds. Subtidal Habitats represent 237 acres or 14.3% of the estuarine habitat.

b. Irregularly Exposed Habitats

6.51 Irregularly Exposed Habitats are areas where the land is exposed by tides less often than daily, and include the tidal creeks ("CR" - 2 acres), some ponds ("PND" - 3 acres) within the salt marshes which are drawn-down, and portions of the intertidal flats ("MF" - 330 acres). The extensive linear man-created ditches which often cut through the high marsh areas were not usually considered as creeks and were not mapped. The intertidal flats, or unconsolidated shores, appear to be composed principally of silt and clay-sized mineral sediments with organic detrital matter. Irregularly Exposed Habitats represent 335 acres or 20.2% of the estuarine habitat.

c. Regularly Flooded Habitats

6.52 The Regularly Flooded Habitat represented 7.0% of the estuarine area, an estimated 115 acres. Areas delineated within this zone are exclusively dominated by saltmarsh cordgrass (Spartina alterniflora), and comprise the traditional "low salt marsh" of the northeast coast. These areas are delineated as "SAT" on the cover maps, distinguishing the tall form of S. alterniflora (>0.8m) from less-frequently flooded shorter forms (Reinert et al., 1981; Teal, 1986). Associated species which may occur within this zone include glassworts (Salicornia spp.), sea lavender (Limonium nashii) and spike grass (Distichlis spicata). Often, this delineated cover type includes small creeks within it.

Table 6.4 Acreages of Cover Types for the Saugus/Pinas Rivers Estuary

Cover Type	SUB-TIDAL			IRREG. EXPOSED			REG. FLOODED		IRREGULARLY FLOODED										SEASONALLY FLOODED			Total Acreage
	TE	PND	CE	HP	SAT	RM	SPESP/DS	DS	JG	SAM	SAS	PAN	IF	NV	BM	PH	TY	LY	SS	WS	UPL	
Acreage	236.50	2.71	1.66	330.11	115.47	180.56	510.42	18.80	2.67	25.57	33.37	14.11	15.07	2.58	2.03	140.91	8.61	0.27	5.46	3.20	6.64	1656.72
% of Total	14.3	0.2	0.1	19.9	7.0	10.9	30.8	1.1	0.2	1.5	2.0	0.9	0.9	0.2	0.1	8.5	0.5	0.02	0.3	0.2	0.4	

Notes: 1. See Table 6.3 for cover type legend.

2. Upland was plannimetered only when surrounded by non-upland habitat.

Table 6.5 Summary of Percent Frequency of Occurrence of Species Present
in the Project Area Salt Marsh Transects

<u>Species</u>	<u>Percent Frequency of Occurrence¹</u>
<u>Spartina patens</u>	86
<u>Distichlis spicata</u>	67
<u>Atriplex patula</u>	35
<u>Spartina alterniflora</u>	30
<u>Juncus gerardii</u>	17
<u>Puccinellia maritima</u>	14
<u>Salicornia europea</u>	13
<u>Solidago sempervirens</u>	12
<u>Limonium nashii</u>	9
<u>Agrostis stolonifera</u>	8
<u>Iva frutescens</u>	8
<u>Panicum virgatum</u>	7
<u>Juncus balticus</u>	6
<u>Teucrium canadense</u>	5
<u>Unidentified grass</u>	4
<u>Triglochin maritima</u>	4
<u>Agropyron pungens</u>	3
<u>Convolvulus sepium</u>	2
<u>Amoracia lapathifolia</u>	2
<u>Spartina pectinata</u>	2
<u>Euthamia tenuifolia</u>	2
<u>Rosa sp.</u>	1
<u>Myrica pensylvanica</u>	1
<u>Spiraea latifolia</u>	1
<u>Suaeda maritima</u>	1
<u>Chenopodium album</u>	1
<u>Vicia cracca</u>	1
<u>Polygonum ramosissimum</u>	0.5
<u>Parthenocissus quinquefolia</u>	0.5
<u>Artemesia biennis</u>	0.5
<u>Solidago rugosa</u>	0.4
<u>Unidentified herb</u>	0.4
<u>Hierochloe odorata</u>	0.4
<u>Calystegia sepium</u>	0.4

Total number of 1m² plots in project area salt marshes = 207

¹Percent frequency of occurrence = number of 1m² plots in which a species occurs ÷ total number of 1m² plots.

Table 6.6 Summary of Percent Frequency of Occurrence of Species Present in the Upper Saugus River and Shute Brook Transects

<u>Species</u>	<u>Percent Frequency of Occurrence</u>
<u>Typha</u> spp.	82
<u>Lythrum</u> <u>salicaria</u>	36
<u>Phragmites</u> <u>australis</u>	28
<u>Convolvulus</u> <u>sepium</u>	23
<u>Polygonum</u> <u>hydropiper</u>	18
<u>Spartina</u> <u>alterniflora</u>	15
<u>Peltandra</u> <u>virginica</u>	13
<u>Toxicodendron</u> <u>radicans</u>	8
<u>Symplocarpus</u> <u>foetidus</u>	8
<u>Acer</u> <u>platanoides</u>	8
<u>Parthenocissus</u> <u>quinquefolia</u>	8
<u>Solanum</u> <u>dulcamara</u>	5
<u>Artemesia</u> <u>biennis</u>	5
<u>Scirpus</u> <u>robustus</u>	5
<u>Armoracia</u> <u>lapathifolia</u>	5
<u>Impatiens</u> <u>capensis</u>	5
<u>Vitis</u> sp.	5
<u>Prunus</u> <u>serotina</u>	5
<u>Sium</u> <u>suave</u>	5
<u>Carex</u> sp. 2	5
Unidentified herb	5
Unidentified grass	5
<u>Phalaris</u> <u>arundinacea</u>	3
<u>Myrica</u> <u>gale</u>	3
<u>Lycopus</u> <u>americanus</u>	3
<u>Carex</u> <u>stricta</u>	3
<u>Euthamia</u> <u>tenuifolia</u>	3
<u>Atriplex</u> <u>patula</u>	3
<u>Agropyron</u> <u>pungens</u>	3
<u>Viburnum</u> <u>recognitum</u>	3
<u>Quercus</u> <u>alba</u>	3
<u>Acer</u> <u>rubrum</u>	3
<u>Cicuta</u> <u>maculata</u>	3
<u>Bidens</u> <u>connata</u>	3
<u>Myosotis</u> <u>scorpioides</u>	3
<u>Nasturtium</u> <u>officinale</u>	3
<u>Cuscuta</u> <u>gronovii</u>	3

Table 6.6 Summary of Percent Frequency of Occurrence of Species Present in the Upper Saugus River and Shute Brook Transects

(Continued)

<u>Species</u>	<u>Percent Frequency of Occurrence¹</u>
<u>Verbena hastata</u>	3
<u>Helianthus tuberosus</u>	3
<u>Unidentified Compositae</u>	3
<u>Solidago sp.</u>	3
<u>Sparganium sp.</u>	3
<u>Carex sp. 1</u>	3
<u>Polygonum sp.</u>	3
<u>Amelanchier sp.</u>	3
<u>Panicum sp.</u>	3
<u>Chenopodium sp.</u>	3
<u>Galium sp.</u>	3
<u>Rumex sp.</u>	3
<u>Aster sp.</u>	3

Total number of 1m^2 plots on Upper Saugus River and Shute Brook = 39

¹Percent frequency of occurrence = number of 1m^2 plots in which a species occurs ÷ total number of 1m^2 plots.

d. Irregularly Flooded Habitats

6.53 These habitats are typically at or slightly above the elevation of mean high tide, such that tidal water floods the land less often than daily. This zone encompasses the traditional "high salt marsh" most often dominated by saltmeadow grass. Much of this community type within the Study Area has been extensively ditched in the past. A total of 955 acres of irregularly flooded habitats comprised 57.6% of the estuarine area.

6.54 Within the irregularly flooded high salt marsh portions of the Study Area, the following cover or dominance types have been delineated:

- . HM: The High Marsh habitat covered 181 acres of the estuary or 10.9% of the total 1656.7 acres. These are areas of high salt marsh in which species interspersation was so varied that individual dominance types could not be delineated. These areas have therefore been grouped into an undifferentiated (by species) high marsh cover type. Typical species composition includes Spartina patens, Distichlis spicata, black rush (Juncus gerardii), and short (<0.3m) Spartina alterniflora. Less abundant but common associates include arrowgrass (Triglochin maritima), sea lavender (Limonium nashii), marsh elder (Iva frutescens) and glasswort (Salicornia europea).
- . SP and SP/DS: There are approximately 510 acres (30.8% of the estuary) of the high marsh where Spartina patens ("SP") clearly comprises a major proportion of the vegetative cover, such that it is considered to dominate the area or where Spartina patens and Distichlis spicata are nearly equally dominant ("SP/DS"). The SP and SP/DS cover type is the most extensive within the high marsh portions of the Study Area.
- . DS: Approximately 19 acres or 1.1% of the 1656.7 acre estuary was assigned this classification. Distichlis spicata, or spike grass, visibly comprises a major proportion of the cover of areas designated as "DS". Within the Study Area such zones appeared to occur in areas of the high marsh which are slightly lower in elevation than areas dominated by Spartina patens, or where surface drainage was slightly impeded. The most extensive stands of this dominance type occurred just east of the old Saugus Race Track and appeared to be associated with past disturbance by man.
- . JG: Juncus gerardii, black rush, was occasionally delineated as a dominance type. The JG designation was determined for approximately three acres or 0.2% of the total area.

- . SAS: These are portions of the irregularly flooded salt marsh where the short form of Spartina alterniflora is dominant, totalling 33 acres or 2% of the estuary. For the purposes of this report, areas where the cordgrass is predominantly less than 0.3m tall are grouped in this category (Reinert et al., 1981; Teal, 1986). Such areas are typically associated with slightly lower elevations than the Spartina patens dominance type, and where surface drainage is impeded. This community type has been associated with higher interstitial salinities and more reduced soil conditions than regularly flooded zones of Spartina alterniflora (Teal, 1986; Niering and Warren, 1980; Nixon, 1982).

- . SAM: There were 26 acres (1.5% of total) where the Spartina alterniflora appeared to reach late-summer heights of 0.3m to 0.8m tall and were differentiated as mid-height zones of saltmarsh cordgrass.

- . IF: The IF classification was assigned to 15 acres or 0.9% of the total. Iva frutescens, marsh elder or high-tide bush, was occasionally delineated as a dominance type where it comprised stands extensive enough to map at the scale being used. This is a woody or semi-woody shrub, normally 1.0-1.5m tall, most often found at the highest elevations of the salt marsh edges or on spoil mounds along mosquito ditches. A thin band of Iva is typical at the edge of many of the marshes, but often was too narrow to delineate for this study.

- . PAN: These 14 acres (0.9%) are areas termed pannes, which are localized depressions in the high marsh which typically are sparsely vegetated with only a few species, and usually have shallow standing water which rarely draws down completely. Short Spartina alterniflora and glasswort (Salicornia europea) are the most common plant species found within these areas, although algal growth may also be extensive. These are distinguished from the following cover type, non-vegetated (NV), by the perception that pannes are formed largely by natural processes (Miller and Egler, 1950; Redfield, 1972).

- . NV: Three acres (0.2%) of non-vegetated areas were delineated within the Study Area high marshes which did not fit the classic definition of panne and appeared to have resulted from relatively recent activities of man.

6.55 In addition to the true salt marsh habitats of the irregularly flooded zone, a number of units were delineated which are comprised of non-halophytes which are subject to tidal inundation on an irregular basis and where salinity data indicated the influence of ocean-derived salts. Two (2) acres (0.1%) of such areas were comprised of a mixed assemblage of plant species with no

apparent dominant species, and were therefore classified as brackish marsh ("BM"). One hundred forty one (141) acres (8.5%) dominated by common reed (Phragmites australis) were designated as "PH". Cattail (Typha spp.) stands in the Study Area were typically found to consist of integrated assemblages of narrow-leaved cattail (Typha angustifolia), broad-leaved cattail (Typha latifolia) and the hybrid blue cattail (Typha glauca), and could not be differentiated within the scale of this mapping. Such areas are labeled generically as "TY" and comprised nine acres (0.5%) of the Study Area. A few areas in the upper estuarine irregularly flooded zone were dominated by purple loosestrife (Lythrum salicaria), and are labeled "LY" for 0.3 acres (or 0.02%).

e. Seasonally Flooded Freshwater Habitats

6.56 Occasionally bordering the wetlands which are irregularly flooded by tidal waters are freshwater wetland habitats dominated by woody vegetation. A total of five acres (0.3%) are classified as shrub swamp ("SS") where the vegetation is less than 20 feet tall; wooded swamp ("WS"), where vegetation is taller than 20 feet, was assigned to three acres (0.2%) of the estuarine area.

Future Without Project Conditions

6.57 In the future, major impacts to the Saugus and Pines Rivers salt marsh are possible from transportation projects. A "Revere Connector" highway from Route 1 to Route 1A could result in the filling of up to 60 acres of salt marsh and isolate up to an additional 200 acres from tidal flooding depending on the precise location and design of the project. If the highway is located above the marsh, on piers, impacts would be significantly reduced.

6.58 The extension of the MBTA Blue Line adjacent to the existing B and M Commuter Line from Revere to Lynn could result in the filling of up to 15 acres of salt marsh and up to 2 acres of common reed marsh. It is assumed here that the bridges over the Pines River and Saugus River would be designed so as not to increase constriction of tidal flow.

6.59 Development of the B&M Commuter Rail Station and 1,000 space parking lot on the Saugus landfill off Route 107 could result in the filling of up to an additional 10 acres.

6.60 The three future transportation plans could result in the filling of a total of up to approximately 90 acres of wetland and the isolation and possible hydrologic impact to up to an additional 200 acres, depending on how these projects are constructed. Such impacts could reduce the fish and wildlife carrying capacity and export capacity of the wetland as well as impacting the aesthetic quality of the area.

6.61 Illegal filling of wetlands could also continue, at the historic rate of about 0.5 acres/year.

6.62 Elimination of outflow from the Strawberry Brook combined sewer overflow and capping of the Saugus landfill will reduce pollutant loads from these

sources to the estuary and wetlands. However, the additional contaminated runoff from the transportation improvements would increase contaminant loads to the southeastern portions of the estuary. Wetlands are known to remove pollutants from waters, mostly by the sediments adsorbing the contaminants. The effects of petroleum hydrocarbons and heavy metals on salt marsh plant growth are not well known at this time, however metals are known to accumulate from the sediments to marsh plants (Teal, 1986; Nixon, 1982; Lee et al., 1978). Salt marsh plants contaminated with metals can form a long-term source of contamination of coastal areas (Teal, 1986). Therefore, any increase in contaminant loads to the marsh could adversely affect the marsh ecosystem.

F. Benthic Habitats

General

6.63 The Saugus and Pines Rivers flow through the approximately 1660 acre Saugus and Pines Rivers Estuary before entering Broad Sound and support approximately 239 acres of subtidal habitat and 330 acres of tidal flats. Additional tidal flats fringe the Lynn and Revere shorefronts. These areas are significant EQ resources (ecological) and are habitat for significant NED resources: finfish and shellfish.

6.64 It is generally recognized that tidal flats are an important component of the estuarine environment and are physically and biologically linked to other coastal marine systems (Whitlatch, 1982). Organisms inhabiting tidal flats rely upon organic materials (e.g. plankton, detritus) transported from adjacent salt marsh, coastal and riverine habitats. The abundant and diverse populations of invertebrates and vertebrates that utilize the tidal flats as nursery and feeding grounds are indicative of the high productivity of tidal flats. In addition, many tidal flats, such as the ones in the Study Area, support populations of commercially and recreationally important shellfish and marine worms.

6.65 The Lynn-Saugus Harbor area, including Revere, the Saugus River and Pines River contain productive soft shell clam and blue mussel habitat (USACE, 1986; USACE, 1985 a,b). Qualitative observations on the productivity of the soft shell clam (*Mya arenaria*) habitat in the Saugus-Pines Rivers Estuary have recently been made (HMM Associates, 1986; USFWS, 1984, 1985). Quantitative sampling has been conducted by the Corps of Engineers. The tidal flats of the Saugus River have abundant populations of soft shell clams. High densities of soft shell clams are also thought to occur along the entire length of the Pines River from the confluence upstream to the Sea Plane Basin. Blue mussels (*Mytilus edulis*) form bars on the gravel-cobble substrate areas of the Pines River, and are extremely abundant on portions of the intertidal flats of Lynn Harbor.

Historical Conditions

6.66 Development over the last 100 years has resulted in losses of saltmarsh habitat, intertidal mudflats, and subtidal habitat. Losses have resulted mainly from commercial and residential development along the banks of the

Pines and Saugus Rivers Estuary and transportation and industrial developments in the estuary proper. Construction of the Lynn Harbor bulkhead has resulted in some loss of intertidal sand flats.

6.67 The tidal flats of the Saugus and Pines Rivers Estuary were the primary source of soft shell clams in the early twentieth century, but increasing pollution resulted in harvest restrictions in most of the area by 1926. At the present time, only Master Diggers and their employees may harvest the shellfish beds in the Saugus and Pines Rivers, with the shellfish then requiring depuration at the shellfish purification plant in Newburyport.

6.68 Previous studies conducted on the benthic fauna in the Study Area include a survey of the area by Chesmore et al. (1972), and environmental assessments conducted by the Corps of Engineers for the proposed Revere Beach erosion control and Saugus and Pines River Navigation improvement projects. Chesmore et al. (1972) discovered that soft shell clams (Mya arenaria), blue mussels (Mytilus edulis), duck clams (Macoma balthica), tellin shell (Tellina sp.), northern moonshell (Polinices heros), clam worm (Nereis virens), blood worm (Glycera branchiata) and the ribbon worm (Cerebratulus lacteus) were present in the area. Benthic studies conducted by the Corps of Engineers indicated that the Lynn-Saugus Harbor area, including Revere Beach and the Saugus and Pines Rivers, contain significant soft shell clam and marine worm habitat (USACE, 1986; USACE, 1985a,b).

Existing Conditions

6.69 Ten general areas in the Saugus and Pines Rivers Estuary were studied on the basis of the potential impacts of the regional plan (floodgate) and/or local protection project plans. Both subtidal and intertidal areas were sampled to determine species composition, mean number of taxa, mean abundance and biomass (see Figure 6.3). In addition, shellfish censuses were done in the intertidal area (see Figure 6.4).

a. Subtidal habitats

6.70 Species composition was generally similar among all subtidal stations. The five dominant taxa at subtidal stations were Oligochaete spp., Capitella spp., Streblospio benedicti, Polydora ligni and Nereis spp. (See Table 6.7). This is not surprising as qualitative evaluation of substrate types among stations indicate that most of the subtidal stations have fairly similar sediment facies. Most of the material consists of sandy-silt or silty sand.

6.71 There were differences in mean abundance and mean number of taxa among subtidal stations. The mean abundance varied from 2990 organisms per square meter at the confluence of the two rivers to 57,600/m² at the Pines River marsh site. Mean number of taxa varied from 10 at the Shut^c Brook site to 26 per station at the Pines River marsh site. These differences can be attributed to differences in the physical location of the stations (see Figure 6.3).

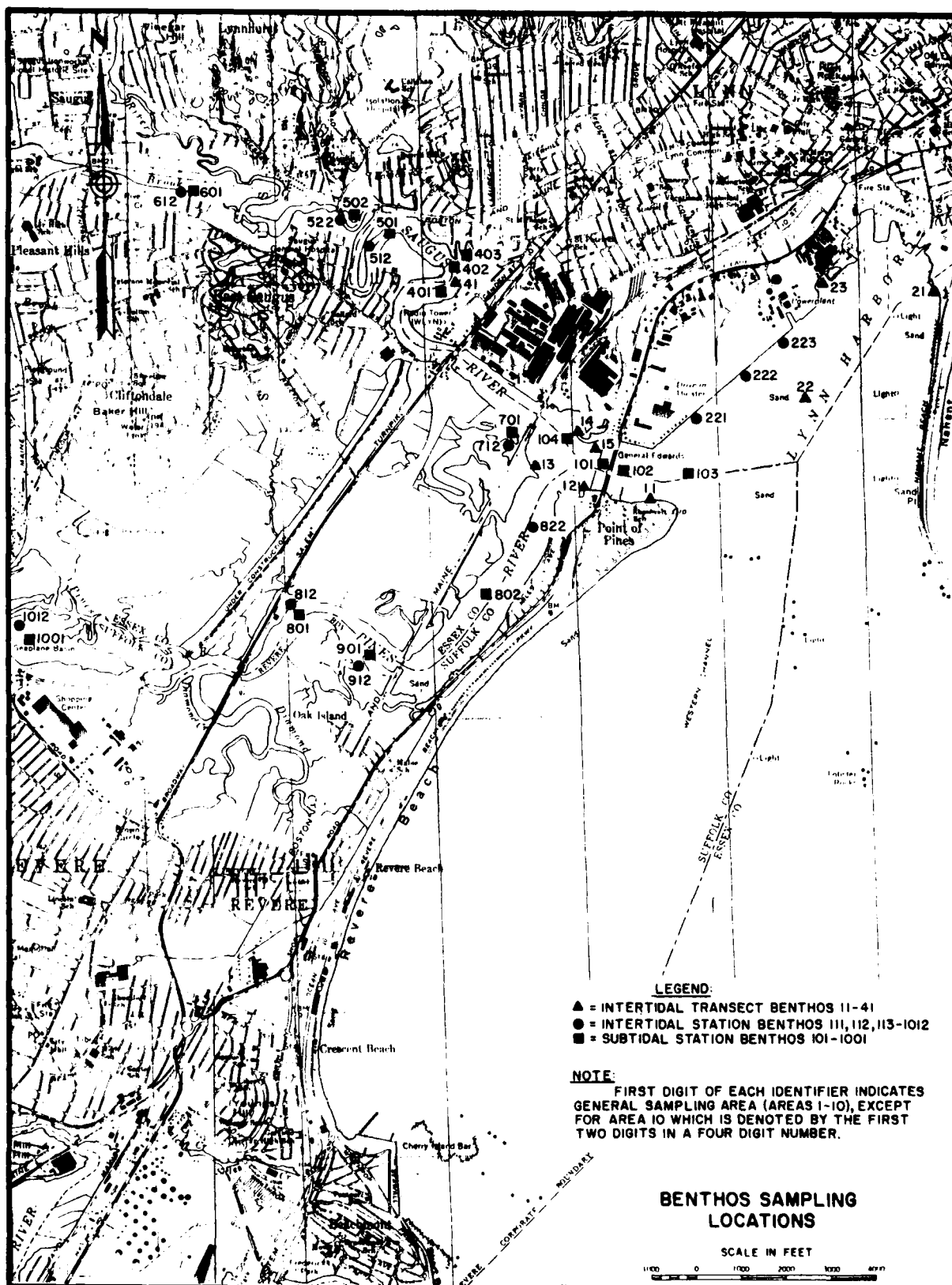


FIGURE 6 3

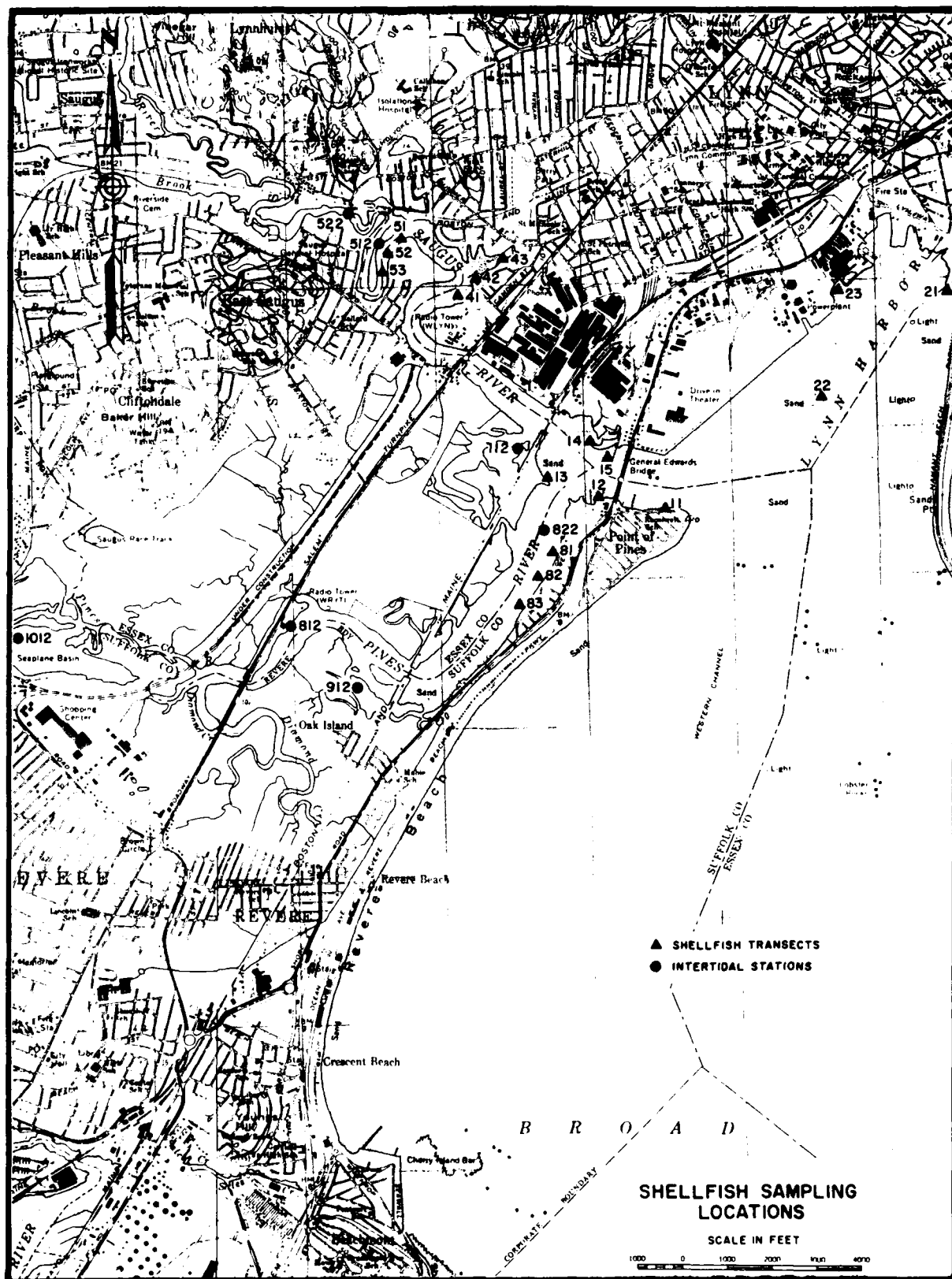


FIGURE 6.4

TABLE 6.7 NUMERICALLY DOMINANT MACROBENTHIC TAXA COLLECTED AT SUBTIDAL STATIONS

Area Station	Taxon ^a	%	Area Station	Taxon	%	Area Station	Taxon	%
1 101	<u>Capitella capitata</u>	40.8	4 402	<u>Oligochaeta</u>	84.8	7 701	<u>Streblospio benedicti</u>	68.2
	<u>Oligochaeta</u>	31.3		<u>Capitella capitata</u>	6.8		<u>Capitella capitata</u>	14.1
	<u>Streblospio benedicti</u>	11.3		<u>Streblospio benedicti</u>	3.5		<u>Oligochaeta</u>	9.6
	<u>Caulerielia sp B</u>	5.2		<u>Nereis diversicolor</u>	2.6		<u>Polydora ligni</u>	2.3
	<u>Polydora ligni</u>	4.8		<u>Nereis spp.</u>	2.2		<u>Spio setosa</u>	2.0
	Percent of Total	93.4		Percent of Total	99.9		Percent of Total	96.2
	Total No. ind./sta.	230		Total No. ind./sta.	854		Total No. ind./sta.	4,697
102	<u>Oligochaeta</u>	23.6	403	<u>Streblospio benedicti</u>	68.6	8 801	<u>Paraonis fulgens</u>	20.8
	<u>Capitella capitata</u>	22.8		<u>Polydora ligni</u>	9.7		<u>Capitella capitata</u>	20.3
	<u>Polydora ligni</u>	14.9		<u>Oligochaeta</u>	9.5		<u>Caulerielia sp B</u>	18.8
	<u>Aricidea catherinae</u>	13.6		<u>Nereis diversicolor</u>	5.2		<u>Oligochaeta</u>	15.2
	<u>Caulerielia sp B</u>	6.2		<u>Nereis spp.</u>	4.9		<u>Aricidea catherinae</u>	8.0
	Percent of Total	81.1		Percent of Total	97.9		Percent of Total	83.1
	Total No. ind./sta.	390		Total No. ind./sta.	1,995		Total No. ind./sta.	664
103	<u>Polydora ligni</u>	35.8	5 501	<u>Streblospio benedicti</u>	48.8	802	<u>Capitella capitata</u>	33.7
	<u>Capitella capitata</u>	10.0		<u>Oligochaeta</u>	30.2		<u>Oligochaeta</u>	22.2
	<u>Oligochaeta</u>	8.3		<u>Nereis diversicolor</u>	6.7		<u>Aricidea catherinae</u>	20.6
	<u>Aricidea catherinae</u>	6.7		<u>Scolecoides viridis</u>	5.9		<u>Streblospio benedicti</u>	9.5
	<u>Petricola pholadifor</u>	6.7		<u>Polydora ligni</u>	2.6		<u>Polydora ligni</u>	3.1
	Percent of Total	67.5		Percent of Total	94.2		Percent of Total	89.1
	Total No. ind./sta.	120		Total No. ind./sta.	744		Total No. ind./sta.	927
104	<u>Oligochaeta</u>	54.0	502	<u>Oligochaeta</u>	56.7	9 901	<u>Streblospio benedicti</u>	62.2
	<u>Capitella capitata</u>	16.7		<u>Streblospio benedicti</u>	27.4		<u>Caulerielia sp B</u>	12.2
	<u>Polydora ligni</u>	8.6		<u>Nereis diversicolor</u>	5.4		<u>Oligochaeta</u>	9.4
	<u>Caprellidae</u>	8.6		<u>Scolecoides viridis</u>	3.1		<u>Polydora ligni</u>	4.4
	<u>Corophium insidiosum</u>	1.9		<u>Nereis spp.</u>	2.8		<u>Cirratulidae</u>	3.8
	Percent of Total	89.8		Percent of Total	95.4		Percent of Total	92.0
	Total No. ind./sta.	359		Total No. ind./sta.	3,489		Total No. ind./sta.	6,912
4 401	<u>Polydora ligni</u>	30.5	6 601	<u>Oligochaeta</u>	65.8	10 1001	<u>Oligochaeta</u>	44.8
	<u>Oligochaeta</u>	29.5		<u>Hypaniola florida</u>	18.0		<u>Paraonis fulgens</u>	10.8
	<u>Nereis diversicolor</u>	14.7		<u>Cyathura polita</u>	7.6		<u>Capitella capitata</u>	7.2
	<u>Nereis spp.</u>	13.1		<u>Nereis diversicolor</u>	5.7		<u>Gemma gemma</u>	6.5
	<u>Spio setosa</u>	3.7		<u>Ampharetidae</u>	1.6		<u>Aricidea catherinae</u>	6.1
	Percent of Total	91.5		Percent of Total	98.7		Percent of Total	75.4
	Total No. ind./sta.	1,133		Total No. ind./sta.	2,051		Total No. ind./sta.	657

6.72 There was a general trend toward increased abundance and decreased number of taxa as one moves from the mouth of the river to the upper reaches of the Saugus River. This corresponds with a slight trend from estuarine to riverine conditions in temperature, conductivity and dissolved oxygen in the Saugus River. Lowest temperatures were recorded near the mouth of the river and highest temperatures were recorded upriver. Dissolved oxygen decreased upriver from 8.6 mg/l to 5.0 mg/l. Shute Brook had the lowest conductivity value, suggesting a predominance of freshwater inflow.

6.73 No upriver trends in oxygen, conductivity or temperature were evident in the three stations located in the Pines River, suggesting the water in this area is fairly well mixed. Correspondingly, no upriver trends were noted in abundance or number of taxa for the Pines River.

6.74 The highest mean abundances of all subtidal stations occurred at the marsh stations. The polychaete, Streblospio benedicti, dominated at both stations and represented over 60 percent of the fauna at these stations. This species is typical of organically enriched areas (Pearson and Rosenberg, 1978).

6.75 In general, the similarity in composition of dominant taxa at each subtidal station within a given area suggests that habitat characteristics within a given area are similar. Differences among stations can generally be attributed to differences in sediment types or water quality (as in Shute Brook). The muddy areas were dominated by opportunistic polychaetes; the sandier stations had a more even distribution of organisms.

b. Intertidal habitats

6.76 Similar species were dominant at all the intertidal stations. Species such as Oligochaeta spp., Capitella spp., Streblospio benedicti, Polydora ligni, Nereis spp. and Pygospio elegans are opportunistic species, which occurred at most of the stations. These taxa tend to be generalists that exhibit wide tolerances for differences in sediment characteristics. Mean abundance and the mean numbers of taxa varied considerably among areas for all tidal heights. Highest densities of individuals and greatest number of taxa were generally observed at mid-tide levels. Comparing the mid-tide levels, mean number of individuals varied from 7,800/m² at the Sea Plane Basin to 161,100/m² at the Pines River marsh site. Mean number of taxa varied from 7 at Shute Brook to 21 at the Pines River Marsh site.

6.77 These results are not unexpected given the wide variety of station locations, exposure regimes (tidal heights) and sediment types both among and within areas. Although grain size distribution of stations within an area varied widely, the grain size tended to be more similar among stations located along an intertidal transect than among stations at the same tidal height. These patterns account for much of the variability observed in mean abundance and mean number of taxa among stations and areas. In general, at a given tidal height, stations with finer sediments were characterized by higher abundance and lower diversity of organisms, while sandier sediments were

characterized by decreased abundance and an increased number and more even distribution of taxa. Further details can be found in the Environmental Appendix.

c. Shellfish

6.78 To evaluate the potential impact of the project on shellfish resources in the Study Area, a shellfish census was conducted. Six species of shellfish were collected: Mya arenaria, Macoma balthica, Gemma gemma, Ensis directus, Mytilus edulis, and Geukensia demissa. The soft shell clam (Mya arenaria) and the Blue mussel (Mytilus edulis) were the most common shellfish collected in this survey. Soft shell clams were found at high densities (up to 358/m²) in the upper Saugus River near the CSO and beyond. Highest Mya densities were found at the mid tide-level. Soft shell clam densities in the Study Area are summarized, by location, in Table 6.8. The size distribution of Mya arenaria collected indicates the presence of several year classes in these areas. Based on the minimum and maximum lengths of the individuals, the approximate ages ranged from one year (0-29.9mm) to over seven years (> 80.0mm) among the stations where Mya arenaria were collected (Brousseau, 1978). The areas that would be impacted by structures of the Regional Saugus River Floodgate Plan had low to moderate densities of soft shell clams, ranging from 0 to 108/m². A density of 50/m² is considered to be a reasonable representation of the overall impacted areas.

6.79 Mussels were found in high concentrations along the shore of the Pines River (up to over 3000/m²) and along the Lynn Harbor shore (up to 100/m²). Abundances as high as 16,480/m² have been reported near the mouth of the estuary (OESC, 1974).

6.80 Other species of clams were found in low densities. The razor clam, Ensis directus, was found incidentally in both the Pines and Saugus Rivers. Macoma balthica was found in the marshy areas and Gemma gemma was found primarily in the Pines River marsh site and the Sea Plane Basin. The latter two are not commercially harvested, but provide forage for finfish and waterfowl.

Table 6.8 Soft Shell Clam Densities in the Study Area (Mya/m²)

Transect ^a	Station 1 High tide	Station 2 Mid tide	Station 3 Low tide
Area 1			
11	0	3	17
12	25	0	0
13	43	0	0
14	58	58	0
15	43	50	0
Area 2			
21	0	0	0
22	8	33	0
23	0	0	108
Area 4			
41	8	225	42
42	292	175	8
43	67	42	0
Area 5			
51	25	133	142
52	8	192	217
53	25	358	142
(512)		0	
(522)		0	
Area 6			
(612)		0	
Area 7			
(712)		8	
Area 8			
81	0	0	0
82	0	0	0
83	0	0	0
(812)		17	
(822)		8	
Area 9			
(912)		25	
Area 10			
(1012)		50	

^a Transects in parentheses are single stations.

Future Without Project Conditions

6.81 Little additional development in the Saugus and Pines Rivers Estuary is anticipated except for possible transportation projects. These may impact intertidal and subtidal habitat. The proposed improvement dredging in the Saugus River would designate a Federal Channel in the area. This would result in a loss of both subtidal and intertidal habitat. Subsequent maintenance dredging which would be required periodically would not remove additional habitat. Improvement dredging in the Pines River could result in additional loss of habitat.

6.82 Various flood protection plans have been proposed for the Study Area. They include 1) construction of the Roughans Point, Revere, Flood Damage Reduction Project; 2) construction of the MDC Town Line and Linden Brook Flood Control Project; 3) continued maintenance of existing non-Federal flood and erosion control shorefront structures along the Saugus River, the Pines River and Broad Sound, and 4) beach restoration and stabilization of the seawalls at Revere Beach with sand from the I-95 embankment. Each one of these projects can potentially result in some loss of intertidal habitat. The impacts of the Roughans Point and Revere Beach projects on benthic habitat are addressed in two separate environmental assessments on file at the Corps of Engineers. Both predict that these projects can occur without significant impacts to benthic habitat.

6.83 Improvements to water quality associated with elimination of the combined sewer overflow in the Saugus River and capping of the Saugus landfill could potentially result in the opening of this highly productive clam flat for recreational diggers.

6.84 Development of the Lynn Harbor area is expected to include condominiums, retail, hotel and office buildings, marina facilities and shorefront structures. Marina development and the building of shorefront structures may result in some loss of habitat. Development of the Harborside Landing Condominium Project will involve some shorefront protection, and loss of intertidal habitat. As well, development just upstream of the General Edwards Bridge, on the Revere side of the Saugus River would involve an enlarged marina and likely habitat loss.

6.85 The existing benthic populations will all undergo natural successions and adapt to the projected dredging and construction activities. Shellfish populations are anticipated to self-perpetuate, given the presence of multiple year age-classes within existing populations.

G. Sandy Beaches

6.86 The only sandy beach in the Study Area is that which forms a crescent shaped barrier spit which is bordered by Broad Sound to the east and the Pines and Saugus Rivers to the west (see Figure 6.1). It extends from the east end of Roughans Point through the Point of Pines area for approximately three miles. The segment from roughly Eliot Circle on the south to Carey Circle on the north is known as Revere Beach. From Carey Circle north to the mouth of

the Saugus River is known as Point of Pines. Coastal erosion and fluctuating sea levels have contributed to the formation of the beach which is composed of Saugus River sand and offshore sand of late glacial age (HMM, 1986). Protection provided from severe storms by Lynn Beach has enabled the beach to grow northward to the mouth of the Saugus River at Point of Pines.

6.87 Prior to urbanization, it would be reasonable to assume that Revere Beach and Point of Pines had resembled a typical northeastern coastal barrier beach. A well-developed barrier beach ecosystem frequently supports a primary dune system dominated by American beach grass (Ammophila breviligulata). The more stable inland dunes are usually inhabited by a heath-like community of low shrubs, and if the conditions are right, a woodland vegetation community can develop behind the dunes typically containing members of the rose family (Godfrey, 1976). In many cases, salt marshes are able to develop behind barrier beaches because of the protection these beaches provide from ocean waves. This is true for both Revere Beach and the adjacent beach at Point of Pines which protect an extensive estuarine salt marsh.

6.87A Because Revere Beach has been altered by over one hundred years of urban development, only a narrow beach with no dunes or beach vegetation remains.

6.88 The Revere Beach Reservation is owned and maintained by the Metropolitan District Commission (MDC) and is the oldest public beach in the country (USACE, 1983a; HMM, 1986). Access to the beach is provided by an adjacent mass transit railway stop and Revere Beach Boulevard which extends the length of Revere Beach. Revere Beach was once a popular public recreation facility for the Boston metropolitan area, and included an amusement park, bars, arcades, and restaurants (USACE, 1983a). The area is now being restored under a Master Plan started in the late 1970s (MDC, 1979). The Master Plan proposes new residential and commercial development and a linear park system. The Master Plan would incorporate traffic improvements, as well as restoration of historic structures to accommodate food concessions, sanitary facilities, bathhouses, amusements, police and maintenance requirements.

6.89 Revere Beach is so narrow that waves hit the Revere Beach seawall at high tide in some areas. Beach profile surveys conducted over the last 140 years have demonstrated that beach sand generally erodes from the central portion of the beach in the vicinity of the bathhouse pavilions (USACE, 1985a). This is due to the advanced development of the backshore and the erection of protective seawall structures. These structures have eliminated the source of localized littoral materials to the shore which formerly provided some equilibrium under natural shore processes (USACE, 1985a). Buildup of material occurs primarily to the north off of Point of Pines and to a lesser extent to the south in the small embankment formed by Roughans Point. To offset the loss of beach material, the MDC placed approximately 172,000 cubic yards of sandfill on Revere Beach in 1954. Subsequent beach erosion control studies conducted by the Corps of Engineers have recommended the placement of an additional 760,000 cubic yards of sand.

6.90 Revere Beach is composed of fine to medium textured sand with a small percentage of silt and gravel (USACE, 1985a). The sand is a mainly gray color, although individual minerals vary from white quartz and buff colored feldspar to reddish brown and black particles. At lower elevations, organic matter accumulates in the sand particles producing an even darker gray cast to the beach. Pockets of gravel and cobble remain on the beach from high energy storms and hurricanes which stir up pieces of gravel offshore and deposit them on the beach. This represents the remainder of the glacial till that supplied much of the sediment in the area (Bohlen, 1978).

6.91 The beach at Point of Pines extends northward from Revere Beach to the mouth of the Saugus River. Point of Pines is a sand spit composed of deposited river sands (USACE, 1984a). The majority of the Point of Pines area is occupied by a densely developed single family neighborhood which is protected by a seawall along the river side of Rice Avenue. The beach area facing Broad Sound supports some developed foredunes and beach vegetation. The dunes are vegetated by American beach grass (Ammophila breviligulata), dusty miller (Artemisia stelleriana) and beach rose (Rosa rugosa). Minimal beach vegetation exists on the river (northern) side of Point of Pines.

6.92 Faunal inhabitation of the Revere and Point of Pines beaches is limited due to the heavy backshore development and recreational use of the beaches. Nevertheless, birds such as gulls, terns, shorebirds and waterfowl may be seen there, as well as rodents, such as rats and mice. The strand line, composed of seaweed (Fucus sp. and other algae) and jetsam, can provide a moist environment for beach-hoppers or the amphipods Orchestia, Talitrus and Talorchestia (Berrill, 1981). Species found on the dunes at Point of Pines might include the dune wolf spider (Lycosa pikei), seaside grasshopper (Trimerotropis maritima) and ant lions (family Myrmeleontidae) (Costello, 1980) as well as migratory passerine birds, especially in the late summer and early fall (USFWS, 1982).

Future Without Project Conditions

6.93 Future conditions without the proposed Federal project would be expected to include continued development of the backshore areas of Revere Beach. Completion of the Master Plan would enhance the attractiveness of the Revere Beach Reservation and be an asset for both residents of the area and visitors alike. Placement of approximately 760,000 cubic yards of sand on Revere Beach by the Corps of Engineers would help protect the seawalls which provide partial flood reduction to the area. No changes in the existing minimal floral and faunal components of the Revere and Point of Pines beach areas are expected.

H. Artificial Shorelines

6.94 Based on maps dated 1900 and a USGS map dated 1946 it can be determined that many of the flood control structures now bordering Lynn Harbor and the Saugus and Pines Rivers Estuary were constructed sometime in the first half of the twentieth century.

6.95 Approximately 8300 feet of dikes and walls exist along the Lynn Harbor shoreline from the location of the General Edwards Bridge north to the Harbor-side Landing Condominium project. The dikes and walls designed to protect development behind the structures are composed of wood bulkheads, stone riprap and metal sheet piling. The wood bulkhead located at the north end of the General Edwards Bridge is in ill-repair and would require eventual replacement. Prior to the construction of the flood control structures along Lynn Harbor, the unfilled area behind the structures contained portions of the Saugus River marsh. This area was filled and flood control structures built to protect development behind these structures. Other artificial structures include the supports of the General Edwards Bridge, pilings of the fishing piers, revetments and bulkheads at the mouth of the Saugus River, as well as various other flood control structures throughout the periphery of the estuary.

6.96 Flora and fauna observed inhabiting the walls and dikes along Lynn Harbor are similar to species typical of open rock surfaces. That is, these species are either attached (e.g. barnacles, mussels and many types of algae) or, if mobile, capable of holding tightly to the surface, such as limpets and periwinkles (Barnes, 1977). The zonal distribution of intertidal organisms on rocky shores is a universal occurrence. Zone level and width are dependent on the degree of exposure to wave action (Newell, 1979). The same factors which contribute to the zonation of intertidal organisms on rocky shores would also be expected to influence the intertidal organisms along the Lynn Harbor shore-front. Species observed in the Study Area are typical of rocky shore species.

6.97 Zones observed include the zone of barnacles (Balanus spp.) which marks the upper limit of the intertidal zone (Berrill and Berrill, 1981). Other competitors cannot tolerate the duration and degree of exposure in the upper intertidal zone. Along the Lynn Harbor shoreline, barnacles extend from the bottom of the flood control structures to a height of about six feet. Located from the bottom of the flood control structures to a height of about three feet are the brown rockweeds (Fucus spp.) and the periwinkle (Littorina littorea). Located at the bottom of the structures are the blue mussel (Mytilus edulis) and the knotted wrack (Ascophyllum nodosum). Brown rockweed and blue mussel are the barnacles' primary competitors which can determine barnacle density in the lower range of the barnacle zone (Berrill and Berrill, 1981). The earlier-mentioned structures at the mouth of the Saugus River, including the supports of the General Edwards Bridge, are also capable of supporting these types of species.

6.98 In general, the type of the flood control structure along Lynn Harbor did not seem to affect the species composition of the organisms attached to the structure. The only exception is the metal sheet piling which was found to contain only barnacle and brown rockweed species.

Future Without Project Conditions

6.99 Without the proposed Federal project, pertinent developments likely to occur would include: the continued maintenance, repair and raising of existing non-Federal structures along Broad Sound and throughout the estuary;

development of the Lynn South Harbor area including the construction of a new bulkhead to replace the degraded bulkhead within the next ten years; and the development over the next five years of the Harborside Landing Condominium project which includes shorefront protection.

6.100 Organisms utilizing currently existing flood and erosion control structures for support will be displaced as the structures are maintained or improved or new structures are built. However, these structures will be recolonized by larvae spawned by adjacent species once maintenance, improvement or construction is complete.

I. Fish

6.101 Finfish species throughout the Study Area can be categorized as National Economic Development and Environmental Quality Resources as part of a complex ecological system.

Historical

6.102 The Saugus and Pines Rivers area has supported subsistence level fisheries since the area was first inhabited by Native Americans. Preferred species included Atlantic salmon (Salmo salar), sea run trout (Salmo sp.) and striped bass (Morone saxatilis) (Lynn School Committee, 1931, cited by Chesmore et al., 1972).

6.103 With the arrival of English colonists in the 17th century, the fishery resources were exploited for both subsistence and commercial purposes. Anadromous fish, including striped bass and alewives (Alosa pseudoharengus) were the principal commercially exploited species (Lewis and Newhall, 1865, cited by Chesmore et al., 1972). Herring (clupeids) and cod (Gadus morhua) were also of importance to early colonists.

6.104 The establishment of the dory and line trawl fisheries in the mid-nineteenth century led to the targeting of haddock (Melanogrammus aeglefinus), cod, mackerel (Scomber scombrus) and tautog (Tautoga onitis) (Chesmore et al., 1972). By the latter half of the 1800's, the area's (Lynn-Nahant-Swampscott district) fisheries were producing large quantities of fish and fish products. Heavy fishing pressure, and presumable habitat degradation led to the extirpation of salmon, shad (Alosa sapidissima) and bass from the estuary by the turn of the 20th century (Chesmore et al., 1972).

6.105 Recreational fisheries became important in Lynn Harbor by the 1950's (Chesmore et al., 1972). Targeted species included mackerel, cod, haddock, pollock (Pollachius virens) and winter flounder (Pseudopleuronectes americanus). By this time, striped bass and presumably shad were reestablished in the harbor and also sought by recreational fishermen.

6.106 In the 1960's the Massachusetts Division of Fisheries and Wildlife (MDFW) initiated a stocking program for the anadromous sea run brown trout (Salmo trutta) in the Saugus River. This effort was designed to establish a self-reproducing stock in the river. The fish were released near the Saugus

Iron Works in quantities ranging from 500 in 1964 and 1965 to 100 fish each year in 1967 and 1968 (HMM Associates, 1986). The program was curtailed in 1968 due to the poor water quality conditions of the river. Brown trout stocking was reinitiated in 1982 by Trout Unlimited and the Malden Anglers (in association with the Massachusetts Division of Fisheries and Wildlife). Some 400 to 850 smolts were released near the Iron Works each year, through 1985 (HMM Associates, 1986). The MDFW released 300 smolts into the upper Saugus River in 1986 and 300-400 in 1988. Smolts were released in the spring (April-May) near where the river crosses Central Street and Route 93 (Peter Jackson, MDFW, 1988 - Personal Communication).

Existing Conditions

a. Ichthyoplankton

6.107 Sampling by MRI (1985) of ichthyoplankton in the Saugus River identified a total of 34 species. Eggs and larvae of several commercially important species such as menhaden, cod, butterfish (Peprilus triacanthus) and flounders were found throughout the estuary.

6.108 Egg density in the Saugus River was highest during June. Predominant species in terms of egg density during this time were mackerel and the flounders. Fairly high egg densities extended from May into mid-summer. Studies by Raytheon (1974) indicate that peak egg density in Lynn Harbor also occurs in June. Larval density peaked in April as a result of winter spawning by species such as Atlantic herring, rainbow smelt, radiated shanny (Uluaria subbifurcata), rock gunnel (Pholis gunnellus), sand lance (Ammodytes) and sculpins (Myoxocephalus spp.). Fairly high larval densities extended from March into June. A much lower secondary peak occurred in late fall due to Atlantic herring.

b. Adult Fish

6.109 A checklist of the adult finfishes occurring in the Saugus and Pines Rivers Estuary and Lynn Harbor in previous studies as well as the current study is provided in Table 6.9. Overall 38 species were noted. Species of commercial and recreational value commonly occurring in the estuary included Atlantic herring, Atlantic tomcod, Atlantic cod, the hakes, bluefish and the flounders. Also noted were five species of anadromous fish: alewife, blueback herring, American shad, rainbow smelt and brown trout. The first four spawn in the upper reaches of the Saugus and Pines Rivers. The stocked brown trout may spawn there. The important anadromous fish runs occur in the spring (April through June). Winter flounder was identified as the most common species. Seasonal changes in finfish abundance in the estuary and Lynn Harbor were evident. The Chesmore et al. (1972) and MRI (1985) studies found that winter flounder were most abundant in the Saugus and Pines Rivers from March through July and in the fall (October or November); spawning probably takes place primarily during March and April and utilization of the estuary as a nursery area extends into the summer. Few winter flounder or other fish were captured from the estuary during January and February. The Raytheon (1974) studies generally captured 1. fish from Lynn Harbor during winter months when

temperatures were low. Demersal fish showed evidence of seasonal peaks in the fall, while pelagic species were most abundant in early summer (June - July). Finfish collected in beach seines (principally Atlantic silversides and striped killifish) were most abundant during the fall (September through November), with minimum abundance occurring in winter and early spring.

Table 6.9 Fishes Recorded from the Saugus/Pines Rivers Estuary and Lynn Harbor in Contemporary Studies (collections made by otter trawl, beach seines, and gill nets)

SPECIES		Chesmore et al. 1972	Raytheon ² 1974	MRI 1985	This Study IEP 1988
Common Name ¹	Scientific Name				
American Eel (c)	<u>Anguilla rostrata</u>	X		X	
Atlantic Herring	<u>Clupea harengus harengus</u>	X		X	X
Alewife (a)	<u>Alosa pseudoharengus</u>	X		X	X
Blueback Herring (a)	<u>Alosa aestivalis</u>	X		X	X
American Shad (a)	<u>Alosa sapidissima</u>			X	
Atlantic Menhaden (s)	<u>Brevoortia tyrannus</u>			X	X
Rainbow Smelt (a)	<u>Osmerus mordax</u>	X	X	X	
Bay Anchovy	<u>Anchoa mitchilli</u>			X	
Atlantic Silverside	<u>Menidia menidia</u>	X	X	X	
Inland Silverside	<u>Menidia beryllina</u>			X	
Mummichog	<u>Fundulus heteroclitus</u>	X			
Striped Killifish	<u>Fundulus majalis</u>	X	X		
Threespine Stickleback	<u>Gasterosteus aculeatus</u>	X	X	X	
Fourspine Stickleback	<u>Apeltes quadracus</u>	X	X		
Ninespine Stickleback	<u>Pungitius pungitius</u>	X			
American Sand Lance	<u>Ammodytes americanus</u>	X			
Atlantic Tomcod	<u>Microgadus tomcod</u>	X	X		
Atlantic Cod	<u>Gadus morhua</u>		X	X	
Silver Hake (or Whiting) (s)	<u>Merluccius bilinearis</u>		X		
Red Hake (s)	<u>Ulophycis chuss</u>	X	X		X
Ocean Pout	<u>Macrozoarces americanus</u>		X		
White Hake (s)	<u>Urophycis tenuis</u>			X	
Northern Pipefish	<u>Syngnathus fuscus</u>	X	X	X	X
Cunner	<u>Tautoglabrus adspersus</u>		X	X	X
Bluefish (s)	<u>Pomatomus saltatrix</u>			X	X
Little Skate	<u>Raja erinacea</u>		X		
Skate	<u>Raja spp.</u>	X		X	X
Grubby	<u>Myoxocephalus genus</u>	X		X	X
Longhorn Sculpin	<u>Myoxocephalus octodecemspinosus</u>	X	X		X
Shorthorn Sculpin	<u>Myoxocephalus scorpius</u>	X			
Winter Flounder	<u>Pseudopleuronectes americanus</u>	X	X	X	X
Yellowtail Flounder	<u>Limanda ferruginea</u>		X	X	
Smooth Flounder	<u>Liopsetta putnami</u>			X	
Summer Flounder	<u>Paralichthys dentatus</u>			X	X
Windowpane Flounder	<u>Scopthalmus aquosus</u>		X	X	X
Striped Bass (s)	<u>Morone saxatilis</u>				X3
Pollock	<u>Pollachius virens</u>				X3
Atlantic Mackerel (s)	<u>Scomber scombrus</u>				X3
Brown Trout (a)	<u>Salmo trutta</u>				X4
TOTAL NUMBER OF SPECIES		20	17	23	18

Notes: 1. c: catadromous
a: anadromous
s: seasonal migrant

2. Commonly occurring in Lynn Harbor or near the mouth of the Saugus River.

3. Noted from IEP's recreational fishery surveys.

4. Stocked by sportsmen's clubs and the Massachusetts Division of Fisheries and Wildlife.

c. Recreational Fisheries

6.110 Winter flounder supports an important recreational fishery. The season starts in April and continues into fall, with the best catches occurring in April (HMM Associates, 1986). Other popular species fished from the shoreline and bridges include striped bass (April - June), bluefish (June - August) and pollock (late June). Anadromous species are targeted either during spring (alewife and blueback herring) or fall (rainbow smelt) runs. During the winter the Sea Plane Basin area of the estuary is a popular location for fishing for mackerel, small Atlantic cod and American eel (Anguilla rostrata).

d. Summary

6.111 In summary, the finfish of the Saugus/Pines Rivers Estuary and Lynn Harbor have been and continue to be an important natural resource to the area. Exploited initially by subsistence level and commercial harvesting, the existing finfish resources within the Study Area are utilized primarily by recreational sportsmen.

6.112 Contemporary field studies indicate that adults of at least 38 species of fish inhabit the estuary and/or Lynn Harbor. About one-third of these are seasonal migrants, catadromous or anadromous species which are likely to be common in the estuary only during part of the year. An additional 13 species are represented solely in the ichthyoplankton. Winter flounder is the most abundant resident species among those of recreational or potential commercial importance.

6.113 Ichthyoplankton studies document the significance of the Saugus and Pines Rivers Estuary as a spawning ground and/or nursery for numerous fish, including commercially and recreationally important species such as flounders, cod and mackerel. Planktonic larvae are most abundant during April (fairly high larval densities extended from March into June); eggs are most abundant during June (fairly high egg densities extended from May into mid-summer); a much lower secondary peak in larval abundance occurred in the late fall. Many of the species that were identified in the Study Area are known to spawn in the nearshore waters of Massachusetts Bay. Pelagic eggs and larvae of these species are transported into the estuary under the influence of tidal currents. Within the estuary, eggs hatch and further larval development occurs. In early spring and fall the planktonic larval community is dominated by species which spawn outside the estuary.

Future Without Project Conditions

6.114 Most anticipated future developments within the Study Area should have little impact on existing fisheries resources in the Saugus/Pines Rivers Estuary or Lynn Harbor. Construction of the Saugus River Navigation Project (USACE, 1986) and possible dredging of the Pines River would have short term, localized negative impacts on water quality, benthic invertebrates and fish.

In the long term, these projects would increase boating activity on the rivers, with possible negative impacts on fisheries due to increased contaminant loading, wake-generated turbidity, etc.

6.115 Over the long term, measures to eliminate combined sewer overflow into the estuary and the capping of the Saugus Landfill would enhance fisheries resources within the estuary. Dredging in the Saugus and Pines Rivers might also improve fish habitat within the estuary by promoting increased flushing of contaminant-rich sediments into Lynn Harbor.

6.116 Several proposed transportation projects would potentially require the deposition of additional fill material into the estuary, with resulting habitat loss for some fish species. Resident species which inhabit intertidal marshes and tidal creeks (i.e. mummichog, striped killfish) and those which use intertidal areas as a nursery, would be most severely impacted by these projects.

6.116A The implementation of the Wetlands Restriction Program would significantly improve the protection of the wetlands, as would stricter water quality standards-both required as part of the ACEC designation.

6.117 There are currently no plans to reintroduce Atlantic Salmon into the Saugus/Pines Rivers Estuary. The sea run brown trout stocking is anticipated to continue as long as State funds or private efforts persist.

J. Lobsters

6.117A Lobsters can be categorized as National Economic Development and Environmental Quality Resources.

Historical and Existing Conditions

6.118 Little is known concerning the abundance and distribution of lobsters (Homarus americanus) in the Saugus/Pines Rivers Estuary and Lynn Harbor. Because lobsters occur infrequently at salinities below 25 - 29 ppt (B. Estrella, Mass. Div. of Marine Fisheries, 1988 - Pers. Commun.), however, it is likely that few are found in the upper reaches of the Saugus River. None are likely to occur where salinities drop below 8 ppt (Cobb, 1976). Lobsters may occur in the upper reaches of the Pines River because there is little freshwater inflow and salinities remain high. Bottom trawls conducted during 1970-1974 (Raytheon, 1974) captured a few lobsters in the lower Saugus River (near the confluence with the Pines River) and in Lynn Harbor. Sampling conducted for this study using otter trawls and lobster traps captured lobsters from the Saugus and Pines Rivers (downstream of the Highway 107 overpass) and from Lynn Harbor (off Point of Pines and in the vicinity of alternative floodgate Alignments 1, 2 and 3). Lobsters were most abundant at stations in the Saugus River (Table 6.10). Lobster density in the vicinity of the proposed floodgate does not appear to be high. An average of about 0.5 lobsters per trap was caught in traps deployed for 24 hours near Alignments 1,

2 and 3. Lobsters caught in the Saugus and Pines Rivers ranged in length from 30 to 119mm (mean=63mm, n = 37). Those caught in Lynn Harbor ranged in length from 56 to 100mm (mean=75mm, n = 11).

6.119 No significant commercial lobster fishery exists in the Saugus/Pines Estuary or Lynn Harbor (B. Estrella, Mass. Div. of Marine Fisheries, 1988 - Pers. Commun.). Although large numbers of lobsters have been landed at the Lynn-Saugus Harbor (Chesmore et al., 1972), most of these lobsters were apparently captured in waters outside the Saugus/Pines Estuary and Lynn Harbor. In the 1987 studies for this report, approximately 80% of the lobsters captured within the estuary, and 65% of those from Lynn Harbor, were smaller than the Massachusetts minimum size limit for legal harvest (81mm).

6.120 Lobsters inhabiting the Saugus/Pines Estuary probably exhibit some degree of movement from shallow inshore waters in summer to deeper offshore waters in winter. Most lobsters collected in bottom trawls by Raytheon (1974) from Lynn Harbor, the mouth of the Saugus River and Nahant Bay were captured between May and October.

Future Without Project Conditions

6.121 Most anticipated future developments in the Study Area should have little impact on lobsters. Construction of the Saugus River Navigation Project (USACE, 1980) and dredging of the Pines River would probably have some short term, negative impacts on lobsters in the rivers, but should have no long term deleterious impact. Lobster habitat in the Saugus River will probably be improved by the elimination of combined sewer overflows.

Table 6.10 Summary of Lobsters Caught in Otter Trawls and Lobster Traps

<u>Location</u>	<u>Otter Trawls</u>		<u>Lobster Traps</u>
	July 87	October 87	July 87
Saugus River			
Station 1	3	2	12
Station 2	8	4	1
Pines River			
Station 1	0	0	6
Station 2	0	1	-
Lynn Harbor			
Station 1	2	1	1
Station 2	1	0	2
Station 3	-	-	5

Note: Total number of lobsters caught in three traps deployed at each location for 24 hours.

K. Wildlife

Marine Mammals

6.122 Local residents describe occasional use of the Saugus River by the Harbor Seal (Phoca vitulina). The National Marine Fisheries Service estimates 2,000 - 3,000 Harbor Seals (primarily juveniles) overwinter in the Cape Cod area (Beach, 1988). Harbor Seals, now only seasonal residents of Massachusetts, can be found in harbors feeding on anadromous fish, shellfish and squid from late September to late May (SES, 1986).

6.123 The White-sided Dolphin (Lagenorhynchus acutus) might be seen close to shore feeding on migratory fish in the late fall/early winter. This species is a year round resident of Massachusetts Bay (Beach, 1988), but prefers open water.

Future Without Project Conditions

6.124 In the future, the Harbor Seal and White-sided Dolphin will continue to use the Study Area occasionally for feeding, as food resources are expected to remain unchanged. A restored Harbor Seal breeding colony in the future is improbable due to the lack of breeding habitat (isolated, undisturbed rocky ledges).

Mammals, Reptiles and Amphibians

6.125 Coastal wetland systems of the glaciated northeast provide excellent habitat for a wide variety of wildlife species. The Saugus and Pines Rivers Estuary is characterized by several distinct habitat types: tidal freshwater wetlands, high salt marsh, regularly flooded or low salt marsh and tidal flats. It is emphasized that the individual habitats do not function as isolated zones; ultimate wildlife value is determined by their interspersions and juxtaposition within the coastal wetland system. In the Saugus and Pines Rivers Estuary, there is relatively good interspersions of habitat types which, when coupled with the large size of the estuary (approximately 1660 acres), indicates a highly valuable and regionally important coastal wetland system.

6.126 Animal species of tidal freshwater wetlands include reptiles, amphibians and furbearing mammals (Odum et al., 1984). The upper Saugus River and Shute Brook comprise a mixture of fresh and brackish waters with a high level of vegetative interspersions. These wetlands were frequented by the Muskrat (Ondatra zibethica), which utilizes the commonly occurring cattail (Typha spp.) as shelter and nesting cover and uses the starchy root stocks for food. In addition, species such as the Cottontail Rabbit (Sylvilagus sp.), Opossum (Didelphis marsupialis), Red Fox (Vulpes fulva) and Raccoon (Procyon lotor) were observed or evidenced by sign in this habitat. Use of the wetland by upland mammals such as the Raccoon, Red Fox and Opossum was more evident in the ecotone (wetland/upland transition) at the wetland perimeter where shrubby vegetation is used as food and cover. The riparian wetlands are also used as

travel corridors. Several amphibians, such as the Red Back Salamander (Plethodon cinereus) and the Wood Frog (Rana sylvatica) were also observed utilizing this tidal freshwater habitat.

6.127 Mammals comprise a smaller and generally less conspicuous part of the high marsh fauna than birds. The Meadow Vole (Microtus pennsylvanicus) is probably the most abundant species, most often inhabiting the high marsh dense grass mat of S. patens and D. spicata. Several other mammals, such as the White-footed Mouse (Peromyscus leucopus), Meadow Jumping Mouse (Zapus hudsonius) and Masked Shrew (Sorex cinereus), are also present. The Norway Rat (Rattus norvegicus) and House Mouse (Mus musculus) were evidenced in many of the small isolated wetlands characterized by Phragmites encroachment, testimony to their adaptability to altered and disturbed habitats. The small burrows and runs encountered during investigations and the presence of the rodent-hunting Northern Harrier (Circus cyaneus) suggest that rodent populations may be high in several areas. Larger mammals such as the Raccoon and the Skunk (Mephitis mephitis) feed on birds eggs and mice in the marsh while their homes are generally in upland trees (Raccoon) and dens (Skunks) (Nixon, 1982).

6.128 The regularly flooded salt marsh functions as a sediment trap for sand and silt particles carried by the ebb and flood of the tides. It is characterized by a wet, muddy substrate and a flat topography dominated by the monospecific Spartina alterniflora, a plant capable of survival in salt water. Numerous tidal creeks, small ponds and pannes occur throughout the low marsh (Teal, 1986). While obvious use of regularly flooded saltmarsh habitat by herpetofauna was not observed during this study, some species may occur. Larger mammals such as Raccoons, Mink (Mustela vison), Weasels (Mustela frenata) and occasionally Red Foxes also feed on shellfish within the intertidal zone.

Future Without Project Conditions

6.129 Future development in the Study Area pertinent to mammals, reptiles and amphibians is expected only from improvements to existing, or construction of new, transportation facilities and possible dredging of the Saugus and Pines Rivers. Thus, with water quality, habitat availability and food resources not expected to change significantly in the future, use of the area by mammals, reptiles and amphibians in the future should not significantly change.

Birds

Historical Conditions

6.130 From a historical perspective, it was written of the Study Area that "The wild fowl were so numerous in the waters, that persons sometimes killed 50 ducks at a shot". This historical account from Lewis and Newhall (1865), however exaggerated, suggests a sizeable duck population. Urban encroachment and the destruction of wetlands in Massachusetts, as well as in northern breeding areas, have undoubtedly led to a decline in duck populations in the Study Area. Historical use of the Study Area wetlands by birds other than

waterfowl is unknown. It may be speculated that similar species utilized the area in the past; however, there may have been a greater diversity of avian species and larger populations of the same.

Bird Habitats

6.131 Tidal freshwater wetlands are the most structurally diverse of the types of coastal wetlands. The edge effect created through the juxtaposition of low marsh, tidal channels, open water areas, shrubs and trees of the high marsh and upland supports a wide variety of habitat requirements and therefore a greater diversity of avian life. For example, herons and shorebirds forage on the exposed mud flats and tidal channels, the shrubs and trees along the marsh-upland ecotone provide nesting sites for many arboreal birds which can be found feeding over the marsh proper, and waterfowl use the marsh surface for nesting as well as the open water for foraging (Odum et al., 1984). In addition, the tidal freshwater wetland provides fresh water to those species incapable of extracting salt through biological mechanisms.

6.132 Tidal flats in the estuary, as well as along the coastal shorefronts in Lynn and Revere, may be exploited by a large number of species. For some, such as herons and shorebirds, tidal flats are absolutely essential habitat, while for others, such as diving ducks, tidal flats at high tide are another potential foraging site (Whitlatch, 1982). Shorebirds feed primarily on invertebrates (mollusks, crustaceans, polychaetes) that are captured on sand beaches and mud flats; different shorebird species may prefer different substrate types. The greater the variety of tidal flat substrate types, the greater the potential diversity of shorebird species. Gulls and terns are most often attracted to shallow water zones to feed on schools of small fish, with the gulls also commonly found foraging in exposed flats or rocky intertidal shores for shellfish.

6.133 In the typical New England saltmarsh, there are only a handful of bird species which nest in the regularly flooded S. alterniflora marsh. They include Clapper Rails (Rallus longirostris), Black Ducks (Anas rubripes), Marsh Wrens (Cistothorus palustris), Red-winged Blackbirds (Agelaius phoeniceus), Sharptailed (Ammospiza caudacuta) and Seaside Sparrows (Ammospiza maritima). Considerably more birds feed within it or use the habitat seasonally for resting or cover than for nesting. Wading birds often stalk the fish and crustacea along the creeks within the marsh (Teal, 1986). The high salt marsh is a more common nesting site for Sharptailed and Seaside Sparrows, and may also serve as nesting habitat for Marsh Hawks (Circus cyaneus), Short-eared Owls (Asio flammeus), Black Ducks, Canada Geese (Branta canadensis), gulls, terns and Red-winged Blackbirds. A number of upland or freshwater wetland bird species use the high marsh as feeding areas, while swallows and chimney swifts (Chaetura pelagica) commonly feed on insects over the marsh (Nixon, 1982).

Breeding Season - Nesting, Resting and Foraging Species

6.134 Among the species reported by local citizens to breed in the estuary and its surroundings are the Eastern Meadowlark (Sturnella magna), Spotted Sandpiper (Actitis macularia), Sharp-tailed Sparrow, American Kestrel (Falco sparverius), Common Tern (Sterna hirundo), Killdeer (Charadrius vociferus), Red-tailed Hawk (Buteo jamaicensis), Black Duck and Mallard. Suspected breeders include: Marsh Wren, Savannah Sparrow (Passerculus sandwichensis) and Blue-winged Teal (Anas discors) (ACECNC, 1988). Extensive censusing was done by IEP, Inc. (1988) for this study. The results are presented in the Environmental Appendix.

6.135 The diversity of wetland types: open riverine water, intertidal flats, tidal fresh/brackish marsh and bordering wood swamp and forest make the Upper Saugus River and Shute Brook attractive to a wide variety of birds which are lacking in the lower estuary. One of the most commonly found are nesting Red-winged Blackbirds. Herons and egrets frequently feed along the rivers' edges and Black-crowned Night Herons (Nycticorax nycticorax) use the area for roosting. Aerial feeding birds such as swifts and swallows are very common due to nearby nesting sites provided by buildings at the Saugus Iron Works. Starlings (Sturnus vulgaris) make use of the upper Saugus River and Shute Brook as brood-rearing, feeding and resting habitat. Black Ducks and Mallards were observed in this area, with their broods, foraging along the rivers' edges. Although no nests were found, it is likely that nesting occurs in the upper reaches of these rivers, within or adjacent to the wetland, where fresh water is accessible.

6.136 The lower Saugus River from the Lincoln Avenue Bridge to the General Edwards Bridge is dominated by areas of open water and tidal flats with limited areas of vegetated salt marsh. Primary inhabitants of these environments as well as the coastal shorefronts of Lynn and Revere are gulls, terns and cormorants which use the area for feeding. Herons and egrets use the tidal flats, tidal creeks and ditches for feeding on invertebrates. These birds nest on isolated islands off site, while utilizing the estuary for feeding to help satisfy the high energetic demands of raising nestlings.

6.137 Concerning Snowy Egrets (Egretta thula), a population census in 1984 found 888 pairs of Snowy Egrets breeding in 14 colonies in Massachusetts (Kent, 1987). The closest colonies to the Study Area were Kettle Island, 22 km north, and three colonies in Boston Harbor. Kent observed all Snowy Egrets leaving the marsh from the 160 acre portion of the estuary behind a barrier spit at the mouth of the Saugus River over a five day period. Of the 120 birds leaving, 75 were observed landing in other parts of the marsh and were excluded from analysis. The remaining 45 individuals engaged in long flights characteristically flew higher and occasionally spiraled on thermals above the marsh. The direction of flight at last visual contact was recorded. Analysis of flight patterns determined that Snowy Egrets consistently flew southward when leaving the marsh. This research suggests that the Snowy Egrets foraging in the Saugus and Pines Rivers Estuary are nesting in Boston Harbor.

6.138 The large expanses of salt marsh provide suitable nesting areas for the Sharp-tailed Sparrow and other ground nesting birds. Herons and egrets could often be seen at the salt marsh. Black-crowned Night Herons were often observed roosting in the shrubs and trees developing along the I-95 embankment. As well, the eastern portions of the Saugus Race Track (on filled portions of the salt marsh) contain forested upland islands, and shrub and tree species invading the salt marsh. As a result, many birds typically found in upland areas, including the Ring-necked Pheasant (Phasianus colchicus), swallows, swifts, Blue Jays (Cyanocitta cristata) and other birds were observed there. Few birds were observed utilizing the wetland areas characterized by Phragmites encroachment.

Migratory Species

6.139 During shorebird migration, particularly during August and September 1987, large groups of shorebirds were observed feeding on the tidal and algal flats and along rocky shorelines in the Study Area. The dominant shorebirds were the Semipalmated Sandpiper (Calidris pusilla), Semipalmated Plover (Charadrius semipalmatus), Short-billed Dowitcher (Limnodromus griseus) and Lesser Yellowlegs (Tringa flavipes), although other shorebirds were observed. Black Ducks and Mallards were also present. Highest use in the estuary during migration was observed in the areas where the salt water begins to be heavily diluted by fresh water, and the diversity of plant species increases, in areas of high interspersed open water and tidal flats and in the Sea Plane Basin (IEP, Inc., 1988). During the fall migratory period (August to October), relatively large numbers (50-100) of Black Ducks and Mallards were observed foraging along the edge of the upper Saugus River. During high tide, these ducks used the adjacent salt marsh as preening and resting areas. The occurrence of duck hunting blinds in various locations throughout the salt marsh adjacent to the lower Pines River suggests that there is frequent use of that area by ducks. Local birders report observing Peregrine Falcons (Falco peregrinus) and Ospreys (Pandion haliaetus) over the marsh during fall migration (USFWS, 1987). These and other raptors undoubtedly occur in both fall and spring. Various species of passerines and other landbirds also migrate through the Study Area in both fall and spring.

Wintering Species

6.140 Significant changes occur in the salt marsh during the winter months. Animal life adjusts to the harsh environment through physiological or behavioral adaptations. Many are resting, hibernating or have migrated south to warmer climates. The more northern the marsh, the less difference the tides make to animals in the winter as ice and snow limits foraging. Feeding activity is generally limited to the open water where ducks and gulls can chase small fish that have been slowed by the cold, or they poke in the mud to sift small worms and clams. Hunting in the marsh is difficult as the mud becomes frozen and worms and insect larvae have retreated deep into the mud (Teal and Teal, 1977).

6.141 Marsh vegetation is also affected by cold winter temperatures. Only the roots survive freezing under a layer of matted vegetation. Seeds are

utilized as a winter food source as supplies are available. Some species found in association with the estuary in winter include the Starling, Crow (Corvus brachyrhynchos) and Ring-necked Pheasant (in the fresh/salt water transition and shrubby areas); Sanderlings (Calidris alba) may be seen foraging along sandy beaches and mud flats and the Herring Gull (Larus argentatus) and Great Black-backed Gull (Larus marinus) are seen foraging or resting in open water habitats. A winter waterfowl census conducted December 18, 1987 showed use of the Saugus and Pines Rivers and Lynn Harbor by Buffleheads (Bucephala albeola), Red-breasted Mergansers (Mergus serrator), Canada Geese, Mallards, Black Ducks, Common Eiders (Somateria mollissima), Brant (Branta bernicla) and Common Goldeneyes (Bucephala clangula). Numerous other species are also found regularly, especially in Lynn Harbor, in winter. Dabbling ducks, such as the Mallard and Black Duck, utilize mud flats during low tide while the diving ducks such as the Bufflehead and the Red-breasted Merganser forage these areas at high tide. Raptors of several species may utilize the marsh in winter and various species of passerines and other landbirds can be found in winter, primarily along the fringes of the marsh. The Snowy Owl (Nyctea scandiaca) may be an infrequent winter visitor to the Study Area (USFWS, 1987).

6.142 The Saugus and Pines Rivers Estuary provides valuable wintering habitat for the Black Duck. A sharp decline in the Black Duck population, nationally, between 1955 and 1962 and a gradual decrease since the 1960's by 1.5 percent a year have caused concern and facilitated implementation of some protection measures (CCP, undated). Hunting mortality, destruction of wetland habitat necessary for feeding and nesting by development and pollution, and the effects of competition and interbreeding with its close relative the Mallard, have undoubtedly contributed to the decline.

6.142A Black Ducks have been identified under the North American Waterfowl Management Plan (NAWMP) and the Atlantic Coast Joint Venture as a species of international concern. The NAWMP is a plan signed by the Minister of the Environment of Canada and the Secretary of the Interior of the United States to maintain the abundance and diversity of waterfowl in North America. Among its recommendations is that, "public works projects planning should include the prevention or mitigation of destruction or degradation of waterfowl habitats." The Atlantic Coast Joint Venture is a method of implementing the plan on the Atlantic Coast. The stated goal of the joint venture is to, "Protect and manage priority wetland habitats for migration, wintering, and production of waterfowl, with special consideration to black ducks, and to benefit other wildlife in the joint venture area."

6.143 Characteristically, Black Ducks strongly attach to specific wintering places, many returning to the same marshes they visited the previous year. Some always winter on the New England coast, moving southward only if the weather is severely cold. Attachment to specific areas is so strong that, in some cases, if the marshes freeze, some Black Ducks have starved to death rather than move southward (Bellrose, 1980).

6.144 Personnel from the Massachusetts Division of Fisheries and Wildlife (MDFW) have conducted winter banding surveys in the upper Lynn Harbor area (at

the head of the causeway to Nahant) since 1966. Formerly, Black Ducks numbered approximately 600 individuals. Recent inventories estimate the Black Duck population to be reduced to a few dozen in the Lynn survey area (H. W. Heusmann, Waterfowl Biologist, MDFW, 1988 - Personal Communication).

6.145 Informal censusing through visual observation by MDFW personnel in the Saugus and Pines Rivers Estuary in recent years estimates from 120 to 180 Black Ducks wintering in the estuary, a slight increase in numbers over the years immediately prior. It is speculated that a reduction in regional wetland habitat, suitable wintering habitat, or perhaps the effects of pollution on food resources in Boston Harbor, have led to the increased utilization of this estuarine/river habitat (H. W. Heusmann, Waterfowl Biologist, MDFW, 1988 - Personal Communication).

6.146 Black Ducks feed on eelgrass, widgeon grass, periwinkles, blue mussels and various snails in water approximately 12 to 18 inches in depth. They are able to feed at different tide regimes, moving out toward the bay as the tide ebbs, and moving in toward the marsh as the tide floods. They utilize the entire Saugus and Pines Rivers Estuary; however, there are three preferred feeding sites: the mussel flats located on both sides of the Saugus River under and around the General Edwards Bridge, and the mussel flats located on the Saugus River directly behind the General Electric plant. The area under and around the bridge is particularly important during the winter months because this section of river seldom freezes. Black Ducks also feed in the high marsh at the higher high tides (for a few to several days each month) on seeds and snails which hibernate in the marsh grass (H. W. Heusmann, Waterfowl Biologist, MDFW, 1988 - Personal Communication).

Future Without Project Conditions

6.147 Future conditions pertinent to birds are the same as those described for mammals, reptiles, and amphibians. Use of the area by birds in the future should not significantly change.

L. Rare, Threatened and Endangered Species

6.148 No Federally listed Threatened or Endangered species are known to exist in the Study Area except for occasional transient or migratory birds, such as the Peregrine Falcon (Falco peregrinus), which may temporarily stop to feed or rest (letter from the U.S. Fish and Wildlife Service dated April 22, 1988). A letter dated April 29, 1988 from the National Marine Fisheries Service confirmed that there are no marine Threatened or Endangered species found in or near the Study Area.

6.149 Review of the Study Area by the Massachusetts Natural Heritage Program (MNHP) yielded a determination that there are currently no verified rare species or ecologically significant natural communities within that area (letter dated April 7, 1987).

M. Social and Economic Factors - Introduction

6.150 Environmental Quality (EQ) resources of the Study Area include the social and economic characteristics of the communities and the cultural resources of the area. This section discusses socioeconomic characteristics of the four communities encompassing the Study Area. This examination of land use patterns and infrastructure will help in understanding what the social and economic future of the area will look like in the absence of any flood damage reduction effort.

N. Land Use

6.151 Being located approximately ten miles from downtown Boston (about 20 minutes commuting time) has had a major influence on the economic growth and land use patterns of the Study Area communities. After World War II, the sites became densely populated bedroom communities of Boston. In the 1970's, with the downturn in the State's economy, the communities suffered from slow economic growth and population decline. With a stronger economy in Boston in the 1980's, the effects have rippled outward to surrounding areas. The recent strong economy of the mid-1980's has increased economic growth and demand for housing in the Study Area.

6.152 Though the population has continued to decline in the communities since 1980, housing demand is rising due to the increased number of households (young adults staying single longer, increased longevity and independence of the elderly). Low property prices in comparison to surrounding communities have also increased the demand for housing. Building permits for new housing construction have been increasing since 1982 in all four communities. The area's proximity to the ocean has led to a great increase in the building of high-priced high rise condominiums along the Revere and Lynn shorefronts. At the same time, officials in the communities are attempting to spur economic growth through aggressive redevelopment plans.

6.153 As for tidal wetlands, historically their loss in these communities has been high, as it has been throughout the Boston metropolitan area. Prior to the mid to late 1960's, there was no wetland legislation to protect wetlands. Currently, however, Federal and State laws and regulations as well as local bylaws, place stringent control on wetlands development. One would expect wetland losses to stop with such protection, but this has not taken place.

Communities

6.154 Data on land use in the communities from 1951, 1971 and 1980 is as published by the Metropolitan Area Planning Council (MAPC, 1986).

a. Lynn

6.155 The city of Lynn with approximately 11 square miles and a density of 7,545 persons per square mile has a greater industrial base than either Saugus or Revere. The largest industry is the General Electric Plant which employs

8,000 people and occupies nearly 130 acres along the Saugus River. The amount of urban land use in Lynn changed only slightly from 1951 to 1980, while agriculture, open land and forest all decreased.

6.156 The wetlands environment, defined as open water and fresh and salt marshes, had a total of 537 acres in 1951. Only 79 acres, or 15 percent, was salt marsh. A loss of 14 acres of salt marsh occurred in a 20 year period between 1951 and 1971 and none were lost between 1971 and 1980.

b. Saugus

6.157 Land use in Saugus is primarily residential and open/undeveloped. Saugus is 11.5 square miles with a population density of 2,357 persons per square mile. From 1951 to 1980 urban land uses, open land and waste disposal increased while agriculture, forests and wetlands decreased.

6.158 In 1951, Saugus had 949 acres of salt marsh. Between 1971 and 1980, the decrease in salt water wetlands was significantly less than in the prior 20-year period. Between 1951 and 1971, some 325 acres were lost to filling. This represented more than one-third of the total salt water wetlands in the town. Most of this filling can be attributed to the I-95 embankment, the RESCO plant and the associated landfill. Between 1971 and 1980, only ten additional acres of saltmarsh were lost.

c. Revere

6.159 Revere, first named Rumney Marsh due to its extensive wetlands, is approximately seven square miles with a population density of 7,443 persons per square mile. Revere today is principally a densely populated residential community with some commercial and industrial uses. From 1951 to 1980 total urban land and wetlands decreased while open land and forest acreage increased.

6.160 The three large wetland systems in Revere have had a major impact on the shape of development patterns. To the east of the city, the Belle Isle Marshes form a boundary between Revere and East Boston and Chelsea. The second major wetland system has mostly been filled in since the early 1900's and is now the site of the Revere High School, Towle Industries and Wonderland Dog Track. Only part of the remaining area is saltwater wetland due to a tide gate preventing salt water exchange. Residential development has grown away from the marsh. The third major wetland system is the Pines River tidal marsh. It can be noted that 75 percent of the 1,109 total wetland acres in 1951 was salt marsh. Of the 837 acres of salt marsh existing in 1951, 33 percent, or 274 acres, were lost in the 20-year period between 1951 and 1971, with no loss measured between 1971 and 1980.

d. Malden

6.161 With 5.13 square miles and a population density of 11,122 persons per square mile, the city of Malden is the most densely populated community in the

Study Area. Its primary land use is residential. From 1951 to 1980, nearly all urban land uses declined except for increases in commercial and transportation uses. No salt marsh existed in Malden in 1951.

e. Summary of Wetland Losses in the Four Communities

6.162 Growth and development of Lynn, Saugus and Revere has had a profound effect on the loss of salt marsh, particularly within the Saugus and Pines Rivers Estuary. While it cannot be determined how much tidal wetland was lost prior to 1951, it is assumed that the loss was significant. Between 1951 and 1971, 613 acres of salt marsh were lost, a loss of 33% over the 20 year period. Two projects (RESCO and the I-95 embankment) located in the central portion of the estuary consumed about 300 acres of the salt marsh; a similar amount was lost around the perimeter of the estuary in Saugus and Lynn. Only ten additional acres were lost between 1971 and 1980. A detailed survey by the Corps (see Plan Formulation Appendix) determined that between 1978 and 1988 wetland losses amounted to about five acres, or an average of 0.5 acres/year. With wetland protection statutes well in place, this represents the rate of illegal wetland filling.

Within the SPN Floodplain

6.163 The primary focus for the socioeconomic assessment is contained below the Standard Project Northeast (SPN) elevation in Lynn, East Saugus and Revere (Malden is not included). It encompasses approximately 3,270 acres in sections of the three communities. In each of these areas, the approximate SPN, the 500-year, the 100-year, the 10-year and the 2-year flood levels have been identified. Current land use was determined by identifying each parcel within the SPN as being residential, commercial, industrial, mixed uses, tax exempt or vacant property. Acreage and the number of parcels were tallied by land use for two zones in the Study Area: (1) between the SPN and the 100-year floodplain boundary, and (2) below the 100-year floodplain boundary.

a. Historical and Existing

6.164 One of the first uses of the Saugus/Pines Rivers Estuary was for the harvest of salt hay to feed cattle during colonial times. The best possible use of a marsh or bog, it was believed, was to fill or drain it and use the land for agriculture or development. Filling has occurred, though at a much slower pace since passage of the Wetland Protection Act and publication of its regulations in 1974, amended in 1977, 1978, 1983 and 1987.

6.165 Land uses that displaced the estuary vary in scope. Transportation uses are the most apparent. Route 107 and the Boston and Maine Railroad traverse the middle of the marsh. Even more obvious is the embankment left from the abandoned Interstate 95 construction project. Industrial uses include sections of the General Electric Plant in Lynn and the RESCO plant in Saugus. The Northgate Shopping Mall in Revere is one of the commercial uses. Also, the marsh was often merely used as a waste disposal area, i.e. the Dematteo Commercial Landfill of 280 acres. In addition, residential uses surround the fringe of the marsh.

6.166 The primary existing land use within the SPN delineation in Lynn is industry. Residential uses comprise the largest number of lots and industrial uses actually make up the greatest acreage at 307.5 acres, or 36.7 percent of the total. There are 66.8 acres of vacant land within the SPN, of which 52.4 acres are within the 100-year flood zone. In Revere, a greater amount of vacant land was determined than expected. Within the SPN, 482.2 acres of vacant land exists; 346.8 acres of vacant land are within the 100-year flood zone. In Saugus, 499.7 acres of vacant land are within the SPN, of which 495.4 are within the 100-year flood zone.

b. Plans for Development

6.167 For the past decade, the city of Lynn has aggressively pursued the revitalization of its residential and commercial neighborhoods. Focus has recently turned to developing large empty parcels of land, three of which are within the SPN floodplain. One parcel is the South Harbor Planning Area, a 70-acre site with 4,000 feet of water frontage and one of the few remaining large waterfront development sites in Massachusetts. Highrise condominiums, offices and a marina are amongst the features planned. The second area is the planned Harborside Landing Condominium Project at the head of Lynn Harbor. The third area is the gateway located near the Fox Hill Bridge on the peninsula jutting into the Saugus River. This 32-acre site has 3,000 feet of frontage on the river and potentially 220,000 square feet of building space.

6.168 In Saugus, the only plan for commercial development within the SPN floodplain is a 5,000 square foot office building off Ballard Street. The largest development plan within the Saugus SPN area is the potential commuter rail station on the Boston and Maine Railroad line. Though this plan is in the preliminary stage, it has begun to attract interest in development in the East Saugus area.

6.169 Of the three communities in the SPN floodplain area, Revere has experienced the most development, primarily due to condominium construction along Revere Beach. Presently, 24 condominium projects, containing a total of 3,233 units, have been proposed along the shore. Other proposed developments within the SPN floodplain area include an industrial park and city yard adjacent to the Northgate Shopping Center, highrise condominium development and marina expansion just west of the General Edwards Bridge, on the south shore of the Saugus River, a 54-unit townhouse development on Marshall Street, a 65-unit condo project on Naples Street, a 153 room hotel and a 560,000 square foot light manufacturing plant expected to open in 1990. Extension of the MBTA Blue Line to Lynn and construction of a "Revere Connector" highway could also take place in the future within the SPN floodplain.

c. Pressures for Development

6.170 Factual indicators, such as building applications, subdivision approvals, Zoning Board of Appeals rulings, and Conservation Commission Orders of

Conditions were discussed with local officials. Telephone calls and discussions with State and local officials revealed no proposed projects for development within the marsh. Most cited the wetland protection laws as prohibiting such activities.

6.171 However, there were opinions expressed among local developers and residents that there is pressure to develop within the marsh environment. Residents of Oak Island said that incremental, illegal filling of the marsh near them has occurred for years.

d. Barriers to Development

6.172 Regulatory control, topographic constraints and increased planning and engineering costs associated with proposed development in the floodplain and wetlands all contribute to minimize development in the Study Area. Regulatory control exists on Federal, State and municipal levels. Federal regulatory constraints include the National Flood Insurance Program and the Clean Water Act requirements (pursuant to Sections 9 and 10 of the Rivers and Harbors Act) for a Corps permit; State regulatory constraints include the Massachusetts Wetlands Protection Act, Minimum Requirements for Subsurface Disposal of Sanitary Sewage, Waterways Licensing Provisions and designation of the estuarine area as an Area of Critical Environmental Concern, including possible implementation of the Wetlands Restriction Act in 1990. Municipal controls include zoning and subdivision controls, local wetland bylaws and Building Inspectors'/Conservation Commissioners' overviews.

6.173 Topographic constraints includes physical considerations of building construction. Increased cost is associated with planning and engineering details being incorporated into the design phase of projects potentially impacting floodplains and wetlands. All of these factors will provide a barrier to development in the Study Area.

e. Future Without Project Conditions

6.174 Future development within the SPN floodplain area depends on a number of factors: existing land use, amount of vacant land, Federal, State and local regulation, including the community's zoning and subdivision regulations and economics.

6.175 The amount of vacant land available for development within the SPN floodplain varies in each community. Lynn has a total of approximately 67 acres of vacant land within the SPN floodplain area. However, only 43 acres has been coded by the assessor's office as "developable land." The remaining vacant land has been determined to be "potentially developable" or "undevelopable."

6.176 Revere has nearly 156 acres of vacant developable land within the SPN floodplain. The majority of this land is coded as vacant commercial land.

6.177 Saugus appears to have about 496 acres of vacant developable land within the SPN floodplain, but this total includes 457 acres of the marsh.

Parcels in the marsh are coded as developable land by the Saugus Assessor's Office. Excluding vacant land in the marsh, there are 38 acres of vacant developable land, all of it coded as residential land.

6.178 Altogether (excluding vacant land in the marsh), there is a total of about 237 acres of developable vacant land in the SPN floodplain. Of these acres, 121 are in the 100-year flood zone. This developable acreage is divided into 528 lots in the entire SPN floodplain. The 100-year flood zone contains 374 of these lots. At the minimum, 528 additional buildings could be built in the SPN floodplain on these vacant parcels. Potentially, there could be more buildings than these if the larger parcels were subdivided.

6.179 Trends in development since 1982 were assessed by comparing the number of building permits issued for new residential construction in the three communities. Family housing units were counted rather than the number of buildings in order to demonstrate the intensity of development. Commercial and industrial permits were not counted because that development has been too sporadic in the municipalities.

6.180 Permits have increased in all the communities since 1981. The most dramatic increase has been in Revere. Permits for 58 units were issued in 1982 and increased to 641 in 1987; Saugus increased from 121 to 201; Lynn increased from 214 to 450. While the change in Saugus has not been dramatic, it has been steady and strong.

6.181 If the total number of new units are taken as a percentage of the existing units in 1980, Saugus appears to have experienced nearly as much residential growth as Revere. The 998 new units permitted from 1982 to 1987 would be a 12 percent increase over the total 8,307 units in 1980. Revere's new units (2,371) are a 13.8 percent increase from the 1980 total. Lynn has a much lower rate with 1,581 new units, only equalling a 4.8 percent increase over 1980.

6.182 Whether these development trends will continue will depend on a number of factors: continued demand for housing, interest rates, health of the local and regional economy, and housing inventory in the regional market.

6.183 Development will continue within the SPN floodplain area as long as it is economical. The recent downturn in the housing market has slowed the sale of condominiums in the Revere Beach area, for example.

6.184 Future development in the marsh, with the possible exception of planned transportation projects described earlier (see Section 5.07), is precluded by the Wetlands Protection Act. The success of this regulation will be dependent on the various communities' efforts and abilities to enforce the restrictions. Most of the marsh is zoned industrial, except for a portion in Saugus that is zoned floodplain. Revere is in the process of updating its zoning regulations. The Planning Department is proposing changing the zoning in the marsh from industrial to wetlands/conservation. It is likely that illegal wetland filling may continue at a rate of about 0.5 acres/year.

0. Property Values and Housing

6.185 A comparison of housing characteristics between the SPN floodplain area, the four communities and the Boston Standard Metropolitan Statistical Area (SMSA) from the 1980 Census discloses some differences noted below:

1. There is a higher percentage of vacant units and renter occupied units within the SPN floodplain. It is the greater number of seasonal/occasional use units in this area that pushes this percentage higher.
2. Median housing value was lower within the SPN floodplain area than for the communities. In turn, the communities' median housing value was lower than in the Boston SMSA.
3. Neighborhoods within the SPN Floodplain command lower housing prices than other areas within their communities. This is due to the high amount of substandard and deteriorated housing within the SPN floodplain.

6.186 Housing prices within the communities have increased substantially in the past few years as have those over the rest of eastern Massachusetts. In Revere, for example, a house valued at \$41,000 in 1977 would now be valued at \$151,000 (City of Revere Growth Management Plan, 1987).

P. Business and Industrial Activity and Regional Growth

6.187 Within the SPN floodplain area, only the city of Lynn has significant industrial activity. 36.7 percent of the SPN floodplain area in Lynn is used for industry. Manufacturing operations comprise nearly all of the industrial activity. The General Electric plant is the largest manufacturing plant in Lynn.

6.188 Industry within the SPN floodplain in Revere and Saugus is almost nonexistent. Each community has only one major industrial site in that area: the Towle Manufacturing Company is in Revere and the RESCO plant is in Saugus.

6.189 It is important to note that all three of the major industrial activities within the SPN floodplain are located in filled wetlands (General Electric, Towle Manufacturing and RESCO). Since the majority of the estuary is zoned for industrial use, there is some pressure for it to be used for industrial purposes.

6.190 Business activity within the SPN floodplain, similar to the Boston region's economy, is primarily devoted to wholesale and retail trade and services.

6.191 Trends in Boston's regional economy have been toward dispersal and suburbanization. While in 1975 total employment in greater Boston (Boston, Cambridge, Brookline and Chelsea) comprised over 46 percent of the total SMSA

employment, by 1982 it only comprised 42 percent. Of the 90,000 new jobs created throughout the SMSA between 1975 and 1982, 60 percent of these have been located in suburban communities outside of the greater Boston area (American City Corp., 1985).

6.192 Though the Boston area has experienced significant regional growth, it has been slow to appear in the Study Area. (See Paragraph 6.195 for Study Area employment data.)

Commercial Fishing and Commercial Fishing Fleet

6.193 Within the Study Area, lobster harvesting is the predominant commercial fishery. Other commercial fisheries are insignificant in comparison. Little commercial fishing of any type occurs within the estuary itself. However, the estuary does play an important role for other commercial fisheries by providing spawning grounds for juveniles. Lobster is captured in Boston Harbor and beyond and landed at ports in Lynn, Saugus and Revere/Chelsea. Together, the three areas landed 1,060,060 pounds of lobster in 1986, equal to 7.2 percent of all the lobster harvested in Massachusetts in 1986 (Division of Marine Fisheries, 1986). Saugus is the seventh highest ranking port in the State for pounds of lobster landed.

6.194 Shellfish resources are also significant in the Study Area; but, due to the high fecal coliform count, the shellfish beds have been closed to recreational harvest for many years. Only licensed Master Diggers and their employees can harvest shellfish, in a few areas, which must then be depurated before consumption. According to Brad Chase at the Division of Marine Fisheries, the shellfish resources could be of significant commercial value if the "water pollution problems associated with domestic sewage treatment are mitigated."

Q. Employment

6.195 Since the Study Area municipalities are essentially residential suburbs to Boston, the majority of residents work outside the communities. Employment within the Study Area is heavily concentrated in the services, wholesale and retail trade sectors of the economy. The unemployment rate was higher in Revere, Lynn and Malden, and lower in Saugus, in 1987 than it was across the State, which was 3.2 percent. From 1980 to 1984 Malden and Saugus increased their employment by 1.4 percent and 7.2 percent, respectively. This is lower than the Metropolitan Area Planning Council (MAPC) region, which increased by 8.6 percent. Lynn and Revere experienced an even more severe difference from the MAPC region. Revere's employment dropped by 12.6 percent and Lynn's by 4.2 percent. However, Revere appears to have reversed the downward trend, having gained 764 jobs in 1986. Lynn, however, has continued to lose jobs.

R. Population and Community Growth, Including Displacement

6.196 All the communities have experienced a drop in population from 1980 to 1988. Revere and Malden have experienced significant drops. The SPN floodplain area, however, has been projected to increase in population by 5.1

percent from 1980 to 1988. By 1990, the population in Saugus and Revere is projected by MAPC to increase. Though total population has been decreasing in the communities, the total number of households has been increasing, following the national trend. This is a result of higher incidence of divorce, young adults staying single longer and the increased longevity and independence of the elderly.

S. Public Facilities and Services

6.197 Public facilities include all public buildings (e.g. schools, community offices, libraries, police and fire stations), road systems, water control facilities and public utilities (e.g. sewer, electric, gas and water lines). All four communities have well-developed public facilities and related services.

T. Transportation

6.198 The region is characterized by dense residential populations with numerous local roads, some burdened with through traffic going to and from Boston. The marsh has played an important role in transportation planning. Over the years it has provided wide open land for rail and road building that needed only fill (building through existing development requires expensive acquisitions and costly, time consuming infrastructure modifications).

Streets and Highways

6.199 The Revere Beach Boulevard runs along the entire length of Revere Beach, at the immediate shoreline, just inside the existing seawalls.

6.200 Route 1A is a primary south-north artery running through Revere along the barrier beach, over the mouth of the Saugus River via the General Edwards Bridge and through Lynn. Route 1A services the beach area, Wonderland Dog Track, the MBTA Blue Line Station and the commercial areas of Lynn. This route has little access control (except towards the southern approach to the bridge) and is characterized by heavy stop and go congestion.

6.201 Route 107 runs directly through the middle of the Saugus/Pines River marshes. It is a four lane highway connecting central Revere with East Saugus. Traffic moves rapidly across the marsh, but congests quickly on either side. Route 107 is approximately nine to ten feet above sea level.

6.202 The Revere Beach Connector was proposed (as far back as the 1950's) to be a four-lane divided, east-west highway connecting Route 1 to Route 1A, constructed in the marsh. This was to relieve the considerable traffic through local Revere streets that was headed for the beach in summer, and to the race tracks. A large area of fill was deposited just north of Route 107 to observe settling characteristics in anticipation of the Connector's construction. A draft Environmental Impact Statement was issued in 1979, but work on the project was halted by the Massachusetts Department of Public Works. Concern over environmental impacts raised by the Federal Highway Administration, U.S. EPA, Army Corps of Engineers, Coast Guard, Department of

the Interior and the Massachusetts Coastal Zone Management Office have precluded the project to date. However, it is still a possibility for the distant future.

6.203 Interstate 95 was to have run across the marsh from the Northgate Shopping district through Saugus. Its failure is the most significant aspect of the region's transportation network. Ironically, it was not the marsh that precluded its construction, but the interests of Saugus on the northern upland side. The abandoned I-95 embankment crosses the marsh from Northgate to East Saugus.

Rail Systems

6.204 Revere (Wonderland) is the northern terminus of the MBTA's Blue Line, a commuter rail system. The Blue Line accesses downtown Boston via Logan Airport. An extension to Lynn is a possibility for the distant future. The Boston and Maine Railroad is a commuter rail line emanating from Boston and servicing the North Shore. It traverses the marsh parallel to (east of) Route 107. Plans are underway to construct a station in East Saugus, on the Saugus Landfill, off Route 107, within five years.

U. Navigation

Vessel Fleet

6.205 There are about 400 vessels which use the Saugus and Pines Rivers for navigation and pass through the existing 100 foot wide, 27 foot high (in the closed position) navigation opening under the General Edwards Bridge. The bridge can be opened to pass taller vessels. Access is by way of a navigation channel from Broad Sound. The fleet includes 280 recreational power and sail boats and 70 commercial lobster and/or finfish boats upstream of the General Edwards Bridge. In addition, the General Electric River Works is serviced by a fuel barge or tanker about once a month. There are several hundred additional vessels in Lynn Harbor, including the Point of Pines Yacht Club. The rivers are presently used as Ports of Refuge during coastal storms and hurricanes.

Current Velocities

6.206 Currents in the channel at the restricted openings between the piers of the General Edwards Bridge reach 0.8 knots (1.4 fps) during a Mean Tidal Range (MTR). Currents at various locations in the Saugus and Pines Rivers are higher. Although not usually navigated, up to 1.7 knots (2.9 fps) occurs at the Pines River Route 107 Bridge. Maximum currents during a Mean Spring Tidal Range (MSTR) currently reach 1 knot (1.7 fps) at the General Edwards Bridge.

Future Without Project Conditions

6.207 Future navigational use of the rivers should increase only a small amount due to a number of factors, particularly the limited development of

facilities within the estuary as a result of the ACEC designation and other controls. Future navigational use of Lynn Harbor could increase moderately.

V. Recreation and Open Space

Lynn

6.208 There are seven recreational sites within the city of Lynn SPN floodplain. These include two neighborhood playgrounds, two community playfields, one community park, one public boat launching area and one public beach area. The public boat launching area, community park and public beach area are estimated to serve the city-wide population.

6.209 Recreational facilities and open space areas are seen as serving a special need in improving and upgrading Lynn. Renovation of recreational facilities is tied to the long term objective of community development. Included in Lynn's neighborhood revitalization strategy is a provision to upgrade the local parks and improve open spaces since this is seen as a method to help stabilize real property values. It is also believed that these actions will encourage economic growth in the community.

6.210 Part of these improvement plans include increasing pedestrian access to water resources, both to the coast and the river. Currently, access to these sites is limited due to Route 1A creating a physical barrier to access to the oceanfront and the industrial uses along the Saugus River blocking the riverfront.

Revere

6.211 Recreational activities in Revere are dominated by Revere Beach. Since 1896, the beach has been owned and managed by the Metropolitan District Commission (MDC). In 1979, the MDC acquired an additional 13 acres of land adjacent to the beach. Historically, Revere has lacked any local public investment in parks and recreation because private entrepreneurs and the MDC readily provide them. Revere even lacks a public common, unlike the majority of New England towns.

6.212 In most categories, Revere is deficient in recreational facilities according to recreational standards. Within the SPN floodplain, there are eight neighborhood parks, three city-wide parks and two regional parks, including Revere Beach.

6.213 Most residents use recreational facilities outside of the city. There are problems with the run-down condition of most of the facilities due to poor maintenance, poor quality equipment and insufficient amounts of equipment. In a survey conducted by the city, well over 50 percent of Revere's households did not use any of the city parks and playgrounds (City of Revere, 1984).

6.214 Revere has seven marinas, of which six are privately owned. Boating is so popular in the area that plans have been proposed to expand the marinas. Neighborhood opposition, however, has been high against these proposals because of problems with increased traffic and parking.

6.215 Sport fishing for winter flounder, mackerel, striped bass, smelt and codfish is popular at all times of year along the bridges over the Pines and Saugus Rivers, at the Sea Plane Basin and at Point of Pines.

6.216 There are no designated nature walks in Revere. People on their own may stroll through the marsh, and the I-95 embankment forms a walkway through the marsh. It appears that the embankment is also used for dirtbike trails.

6.217 Only one of the recreational facilities in the SPN floodplain area is adjacent to the marsh. Jacobs Park, along Hastings Street, is a five acre proposed park site. Presently, this site is nothing more than a cleared area at the edge of the marsh.

6.218 The MDC is currently upgrading Revere Beach. Plans include new plantings, upgrading park structures, such as the historic pavilions, and improving transportation corridors and pedestrian access to the beach. Revere also has plans to upgrade their recreation facilities.

Saugus

6.219 Within the SPN floodplain in Saugus, there are few recreational facilities. There are three playgrounds and one neighborhood park. One playground is four acres and contains a softball field, play equipment and a basketball court. The Ballard School has a half-acre playground with some recreational equipment. Along the Saugus River, there is a 6.4 acre playground with a Little League field. This facility is in poor condition and is subject to extreme vandalism.

6.220 Lobstermen's Landing/Marine Mini Park is a neighborhood park and boating facility along the Saugus River.

6.220A Saugus is currently updating its open space and recreation plan.

W. Noise

6.221 Ambient noise is a very site specific occurrence, and cannot be generalized for a broad area. Ambient noise levels within the Study Area are difficult to determine since ambient noise levels are not routinely measured. Noise levels are usually measured by local and State government agencies only as related to complaints. Calls to the Department of Environmental Quality Engineering failed to uncover any records of measurements of noise levels at the site of the proposed floodgate and therefore there have probably not been routine complaints of excessive ambient noise there. Future conditions would generally remain the same.

X. Air Quality

6.222 The Commonwealth of Massachusetts is divided into six Air Pollution Control Districts. The Study Area is located within the Metropolitan Boston Control District. The Federal Clean Air Act protects the quality of the air by setting National Ambient Air Quality Standards (NAAQS) for specific criteria pollutants. Criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, lead, total suspended particulates and particulate matter less than 10 micrometers in aerodynamic diameter (PM10)) were measured with both private and public stations equipped with air pollution monitoring equipment in 1986. One private site is located in Lynn at 423 Lynnway Street and measured only sulfur dioxide.

6.223 There were few exceedances of the NAAQS in the Metropolitan Boston District in 1986. The carbon monoxide standard was exceeded twice. The other exceedances were in Chelsea for ozone during two measuring periods.

6.224 A Pollutant Standard Index is a measurement of the ozone in the atmosphere and grades days according to the general health effects of the air. Ozone is only measured from April to October in Metropolitan Boston since it is predominantly a photochemical reaction from other pollutants. Ratings range from good to moderate to unhealthful to hazardous. In 1986, during the 214 day ozone season, 120 days were rated good, 86 moderate and 8 unhealthful. No days were rated above the unhealthful level.

6.225 Predicting the future of air quality within the Study Area is difficult since pollution comes from both distant sources, such as New York and the midwest, and local Metropolitan Boston sources. However, if significant economic growth and housing development occurs in the Study Area, then some increased air pollution can be expected. Increased traffic and fossil fuel emissions would increase the level of all of the criteria pollutants.

Y. Visual Resources

6.226 The visual characteristics of the Study Area are the aesthetic Environmental Quality resources of the coastal communities.

Landscape Inventory and Classification

6.227 The Study Area is a region of strong visual contrasts. One central visual feature of the area is the extensive 1660 acre estuary, the largest in close proximity to downtown Boston. Completely surrounding the marsh are upland areas heavily urbanized with a mix of residential, commercial, industrial and recreational structures. Providing further contrast is the open water of Lynn Harbor and Broad Sound. There is very little change in topography in the local area. Long vistas are only possible along the shoreline, along roadways and the rail line that crosses the marsh, or from a few local buildings.

Assessment of Existing Landscape

6.228 The Study Area has been developed to the point that there is little remaining natural shoreline. Revere Beach is developed for recreation. Small sand dunes and a fronting sand beach exist along the east side of Point of Pines, with the beach extending around the north side of the point. The Lynn shoreline has been replaced by a bulkhead which fronts commercial development and open disturbed land. The backshore of Revere Beach is a mixture of densely developed residential and commercial structures, including high-rise condominiums, or open land awaiting development. Much of the large tidal marsh between Revere Beach and Saugus remains open and undeveloped, but the marsh is segmented by Route 107, the B&M railroad right of way and the fill of the now abandoned right of way for Interstate Route 95. At the north side of the marsh is a large filled area which is now the location of a regional refuse incinerator and power generation plant as well as a landfill operation. Commercial and residential development continues to encroach on the edge of the marsh. The Saugus River is crossed at several points by bridges and pipelines, and is lined with commercial development.

Future Without Project Conditions

6.229 The entire local area is undergoing gradual revitalization which should improve visual quality. The most intensive commercial and residential development should continue to occur along the Lynn bulkhead, in the area between Gibson Park and the General Edwards Bridge in Revere, and along Revere Beach.

2. Historic and Archaeological Resources

6.230 These resources comprise the significant cultural Environmental Quality resources of the Study Area.

Prehistoric Period

6.231 The Saugus and Pines Rivers Estuary provided attractive resources for Native American Groups (Amerindians) living in coastal New England. The mixed resource base of fish, shellfish, waterfowl and nearby upland game would have provided a year-round food supply. Other resources, such as outcrops of bedrock suitable for the manufacture of stone tools (known as "Saugus Jasper") would have also drawn groups to the area. There are historic accounts of Amerindians having small cultivated fields of corn, beans and squash in the Saugus-Lynn area, especially on the south sides of hills in the East Saugus area (Hurd, 1888). There are also historic accounts of Amerindians harvesting marine resources. Early white settlers built fish weirs and harvested anadromous fish and eels alongside the Amerindians. White settlers and Amerindians shared the estuary until at least the late seventeenth century, when Wenepoykin (a.k.a. Sagamore George Rumney Marsh) signed a quitclaim deed for Lynn and Salem.

6.232 Amerindian sites, which may range from temporary, small hunting camps or marine resource harvesting and processing stations to semi-permanent, large base camps or agricultural fields and burial sites have been reported in the Study Area. The majority of these sites appear to represent occupations from 1500 years ago to 350 years ago (Dincauze, 1972; Hadlock, 1949; Johnson and Mahlstedt, 1982; Willoughby, 1935). Burials have been recorded on Oak Island and near the Pavilion, on Revere Beach Boulevard (Shurtleff, 1938). Amerindian sites, including burials, were reported along Lincoln Avenue in East Saugus and in a sandpit off Ballard Street, "near the river" (Elia, 1982).

6.233 Several prehistoric Amerindian sites have been discovered or excavated in similar saltmarsh environments along the New England coast. Extensive evidence of prehistoric Amerindian occupation has been recorded on Nelson Island, in the Plum Island Estuary (Robinson, 1985). Prehistoric human burials, from 4500 years ago, were recovered from the Seabrook/Hampton Estuary in New Hampshire (Robinson, 1985). These burials, which were once on dry ground, are now under marsh vegetation and covered with at least six feet of water at high tide. Depending on the rate and character of the salt marsh accretion, prehistoric sites may be preserved under the salt marsh grasses within the Study Area (Croes, 1976; Kerber, 1984).

6.234 There are historic accounts that "throughout this region of marsh (Lynn-Saugus Estuary) are trunks of great trees, chiefly pines, imbedded from 2-4 feet beneath the surface (of the marsh) and in a good state of preservation" (Lewis and Newhall, 1865-p.77). Some of these trees are reported to "bear the mark of an axe" (p. 408). This indicates that former dry-land surfaces may have been covered over by accreting marsh vegetation. If so, then prehistoric sites, as old as 3,000 to 4,000 years old, might be found in the salt marsh and adjacent uplands.

6.235 Older sites (up to 11,000 years old) may also be present, but may be in different topographic locations, as the rapid post-glacial sea level rise has affected the local topography and related food resources (i.e. older sites may have been in an area that is now offshore).

6.236 Expected site types in the Study Area include fishing stations (weirs and processing/drying areas), shell middens, single or group burials, small campsites, large habitation sites and possible random items, such as dugout canoes buried in marsh grasses. Because of the saturated environment, any sites existing in the salt marsh may contain preserved organic material that is normally not recovered in dry-land sites (Croes, 1976). Therefore, any sites that might be present in the saltmarsh are likely to contain important data classes which may not survive in a typical land site. However, the areas containing intact former dry-land surfaces may be limited; they could be located by identifying dry-land vegetation in cores taken from the marsh.

Historic Period

6.237 The Saugus/Pines salt marsh, called Rumney Marsh by the first settlers, has been used extensively since the earliest period of European settlement

(ca. 1630). While the uplands were being cleared of timber, saltmarsh hay was gathered to provide fodder for cattle and horses. By 1675, English hay was being grown in the area, but many farmers found it more convenient to gather hay from the marsh, and the practice continued up through the mid-nineteenth century.

6.238 The salt marsh has been altered in various ways over the years. Some early farms were built on land reclaimed from the marsh. Roads, turnpikes and railroads have been built across the marsh, drainage ditches have been dug and many areas have been filled for private and commercial use. The development of Revere Beach as a resort and residential community was stimulated by the Saugus Branch Railroad of the Eastern Railroad, which had a depot at Beach Street in the mid nineteenth century. The establishment of land companies, shore railroads and suburban trolley connections sparked a population boom in summer homes. Year round settlement began as early as 1872. Beachfront development reached its peak in 1906 with the construction of the Wonderland Amusement Park (Massachusetts Historical Commission [MHC], 1981, 1985; Tracy et al., 1878; Luedtke, 1977).

6.239 In 1632 Thomas Dexter erected a fish weir and a gristmill on the Saugus River, near the site of the future Saugus Iron Works (1640s - 1688), at the head of the estuary (MHC, 1985). In 1851, B.F. Newhall built a wharf in the lower estuary, taking the fill from the southwest side of Ballard Street, making a millpond there. A gristmill accompanied the millpond, and the grain was landed in boats at the wharf (Hurd, 1888). This may be the same area where a seventeenth century ferry from Lynn landed. The various creeks opening into the salt marsh were excellent locations for providing a readily available power source for tide mills.

6.240 Steady development of the Saugus/Pines Estuary and the surrounding environs over the past century may be seen in a comparison of historic maps of Saugus and Lynn (Walker, 1884) with a modern map of the area, showing extensive modifications. The salt marsh in Lynn has been mostly filled, and the present shoreline is almost entirely artificial. Tidal flats in the Study Area have been slowly filled since the early-mid nineteenth century. Earthen-filled wharves to off-load lumber and coal and a tidal millpond were built along the Lynn shoreline. In the late nineteenth century, filling of tidal lands for residential purposes began. By the early twentieth century, the current shoreline of Lynn was fairly well established. The last major episode of filling came in the 1950s, when the Lynnway was built (Rosebrock, 1981).

6.241 In Saugus, the changes have been less dramatic. Roads have been constructed through the marsh, as well as the I-95 embankment and the Saugus landfill and RESCO facility, and the edges of the marsh have been encroached upon by residential and commercial interests; but the majority of the developments, such as the rights of way for the Salem Turnpike (Route 107) and the Boston and Maine Railroad were already present in 1884.

6.242 Within the Study Area, there are many sites related to transportation. There is a seventeenth-century historic ford in East Saugus, near Chestnut

Street. The rights of way for the Salem Turnpike (established in 1803) and the various railroad lines are still easily discernible. There may be some evidence of early wharves, mill or ferry landings along the edges of the rivers, or buried beneath the marsh. There are also a few commercial/ industrial sites. It operated from the 1640s to 1688. The Saugus Iron Works, a National Historic Landmark, sits at the head of the estuary. It operated from the 1640s to 1688. The Anchor Tavern, a seventeenth century stop for travelers, was located along the Old Boston Road, near the intersection of Lincoln, Ballard and Chestnut Streets. There was at least one tidal gristmill along the shores of the Saugus River (MHC, 1985). The Stocker Brickyards were located in East Saugus, near the Saugus River from the late eighteenth century to the late nineteenth century (now under a playground [Elia, 1982]). Other than the Iron Works, which has been excavated and rebuilt, there may be little visible evidence of the other commercial and industrial sites. They could be located through careful deed research and field investigations.

Future Without Project Conditions

6.243 In the future, there will be developments that may affect either historic or prehistoric sites in the Study Area. All categories of development have the potential to affect these historic properties. Transportation projects that infringe upon the marsh would have the potential to affect well-preserved buried sites.

7.0 Environmental Effects of Detailed Plans on the Previously Described Significant Resources

A. Introduction

7.01 The following sections summarize the environmental effects of each proposed project option on significant resources. The significance of impacts was determined based on the magnitude of impact to resources of institutional prominence, technical merit, public concern or in violation of an institutional standard. Full review of impacts are given to those resources specified in Section 122, 1970 River and Harbor Act (P.L. 91-611).

B. Hydrology and Hydraulics

Tidal

a. General

7.02 Of the three options being evaluated, only Option 3 will have any impact on tidal movement within the estuary. The impact will be the result of placing the floodgate at the mouth of the Saugus River which will prevent tidal flood levels from reaching an elevation which would cause damage within the estuary when the gates are closed (see Hydrology and Hydraulics Appendix).

7.03 Two different mathematical analyses were used concurrently to size the gate openings and define the change in tidal and current fluctuations that will occur if the floodgate is constructed. The first analysis used a hydrologic routing process based strictly on a stage-storage relationship to approximate velocities through the gated openings. The second analysis used a dynamic routing of the tidal wave to approximate the change in timing and water levels at the upper ends of the estuary.

b. Construction Conditions for Option 3

7.03A During floodgate construction at least 5,200 square feet of cross-sectional river opening (flow area) below mean sea level (el. 0 ft. NGVD) would be maintained at all times, similar in cross-sectional area to the N3 gate scheme. Maximum average velocity at this location during a mean tide range would be 1.7 knots (2.9 fps) or roughly twice that of the existing condition at the General Edwards Bridge, which is 0.8 knots (1.4 fps). Tide level changes would be barely noticeable. The time lag in timing of peak high and low tides in the estuary would be on the order of a few minutes. Change (reduction) in flushing volume would range from 0.5 percent for a mean tide range to about 3% for the maximum astronomic range.

c. Operational Modes for Option 3

7.04 Navigation and flushing gates will remain fully open at all times, except when storm tide levels are predicted to be greater than those expected to produce flood damage, approximately elevation 8 feet NGVD. This level is equalled or exceeded about annually at Boston. Gate closure would generally occur at about seven feet NGVD, but closure at a somewhat lower elevation

would be considered based on rainfall intensity, wind direction and velocity, below freezing temperatures (icy streets), snowbanks (street drainage) and other factors. Because of the uncertainties of predicted surge and high tide levels, closure would occur more frequently than once annually. Current estimates of closure are between two and three times a year gradually increasing to 40 with one foot sea level rise. Most closures would take place between mid-October and mid-February.

7.05 The tidal floodgates will generally be closed to bracket the high tide condition and will be opened as soon as the ocean level drops to the level of the backshore area. Since the sinusoidal shape of the tide hydrographs in the Study Area is so steep, the estimated length of time when the tide level would be eight feet NGVD or higher for a minor storm would be only about an hour. Length of closure for most storms would be generally in the range of 1 to 2 hours. The most significant storms associated with events having less than a 1 percent annual chance of occurrence (100 year events) would have closures of about 6 or 7 hours.

d. Impacts on Astronomic Tide Levels and Flushing With the Gates Open

7.06 The model, ODISTM (One-Dimensional Storm Tide Model) which is used by the Federal Emergency Management Agency (FEMA) in its Flood Insurance Program, was used to define impacts of the gated structure with gates fully open on the tide levels behind the structure.

7.07 Various floodgate schemes (differentiated by number and size of openings) were analyzed and the relative changes from a modeled "existing" condition were determined for a range of tidal conditions. In this way, the relative impacts of each scheme could be addressed. Hydrodynamic analyses were completed for the various floodgate schemes. For each scheme, changes in high and low tide levels were compared to the existing condition at several locations within the estuary. Velocities were calculated for existing flows at the General Edwards Bridge and for the various floodgate schemes. Also, additional analyses determined the changes in flushing volumes for each of the floodgate schemes.

7.08 The selected N4 gate scheme, comprising one 100 foot wide by 33 foot high miter gate with unrestricted vertical clearance for navigation and ten 50 foot wide by 14 foot high tainter gates for tidal flushing would provide 8800 square feet of cross-sectional opening below mean sea level (MSL: el. 0 ft.) NGVD, which is 100 square feet more than currently exists at the location of the selected floodgate Alignment 2. The gates would provide 600 square feet more opening below MSL than the 8200 square foot smallest existing cross section near the mouth of the Saugus River.

7.09 Velocities at the floodgate with the N4 gate scheme would be expected to approximate existing velocities at that location or be slightly higher, however detailed modeling will be necessary to refine the design of the floodgates to achieve the optimum matching of the existing condition. Present estimate for the maximum average velocity with the N4 gate scheme during a

mean tide range is 1 knot (1.7 fps). Tide level changes would be barely noticeable for the N4 gate scheme and time lag in the timing of peak high and low tides in the estuary would be a minute or less.

7.10 Since the tidal motion is similar to a moving long period wave it was not possible to determine the exact change in flushing volume for the various floodgate schemes by simply examining changes in tidal timing and levels. Therefore, further analysis was completed to determine the changes in flushing volume for the alternative schemes. The predicted change (reduction) in flushing volume for the N4 scheme came to less than 0.1 percent.

7.10A A detailed analysis of all of the alternative gate schemes is presented in the Hydrology and Hydraulics Appendix.

Flooding

a. Option 1

7.11 The local protection projects would provide protection ranging from the SPN event for the Park Dike area, to the 500 year event for Lynn and East Saugus to the 100 year event for Revere Beach Backshore at the north end of the beach and along the Pines River and Town Line Brook. Low areas behind the local protection structures should be preserved for temporary ponding of freshwater runoff as future flooding in these areas would be related to freshwater runoff and ponding capacity.

b. Option 2

7.12 Nonstructural plans investigated would reduce flooding to individual structures either by raising or floodproofing the structures.

c. Option 3

7.13 The tidal floodgate and appurtenant structures would prevent flooding to the SPN level for all eight floodprone areas in the Study Area, except Point of Pines and the Garfield School Area at the south end of Revere Beach, where flooding would be prevented up to about the 1978 100-year level. Also overtopping will continue along the north end of Revere Beach; however, controlled water levels in the estuary and protection of a natural ponding area would partially reduce flooding in this area up to the SPN event. It should be noted that the floodgates will not be operated to alleviate gravity drainage problems for many low areas around the estuary during normal high tides.

Flood Frequencies

a. Options 1 and 2

7.14 The local protection projects and nonstructural measures previously described would have no impact on the tidal flood frequencies along the coastal shorefront or in the estuary. Frequency of flooding behind the local

protection structures would depend on accumulated rainfall behind the structures and tidal overtopping, and the ponding capacities in those locations.

b. Option 3

7.15 There will be no impact on tidal flood frequencies along the coastal shorefront seaward (on the ocean side) of the floodgate structure. Frequency of flooding behind the coastal shorefront structures would depend on accumulated rainfall behind the structures and tidal overtopping, and the ponding capacities in those locations. Project modified flood stage frequencies inside of the floodgates will depend on the magnitude of residual tidal overtopping and interior storm runoff during project gate closure. The likely interior modified flood stages for the one (100 year) and 10 (10 year) percent chance frequencies are approximately 7.4 and 7.2 feet NGVD, respectively. This is not meant to imply that in the future tides will not exceed 7.4 feet NGVD. The floodgates will generally only be operated when tides are expected to exceed 8.0 feet NGVD.

C. Water Quality

7.16 There would be a temporary increase in turbidity associated with construction of the local protection structures.

7.17 Option 2 would have no water quality impacts.

7.18 Option 3 construction impacts would be a temporary increase in turbidity associated with construction of project structures, including dredging. Operation of Option 3 is expected to produce only minimal changes in existing water quality conditions, including salinity characteristics, since open-gate tide elevations and currents show negligible differences from existing conditions and also since gate closures will happen so infrequently and be of such short duration. The closure event will closely parallel the hydrological equilibriums of normal high tide. The retention of tidal outflow by the closed gates would occur at the diurnal high tide events. The gate closures would only alter infrequent tidal peaks. Further, significant freshwater runoff would generally not coincide with closure, as has been shown by hydrologic analysis, thus minimizing potential salinity impacts. Moreover, the momentum of the tides and wind-driven waves would continue to mix water in the estuary during closures.

7.18A Water quality should be improved with elimination of flooding around the estuary which would otherwise carry undesirable waterborne elements from manufacturing buildings, warehouses, potentially broken gas and oil lines, debris and other pollutant sources back into the estuary.

D. Estuarine and Coastal Resources - Introduction

7.18B The following sections describe impacts on estuarine and coastal resources of the Study Area.

E. Wetlands

Option 1 (Local Protection Plans)

a. Construction Phase Impacts

7.19 Construction phase impacts of the Local Protection Plans (LPP's) involve disturbance of the marsh surface from placement of materials, construction activity and erosion/sedimentation. Up to about ten acres of wetland would be susceptible to temporary impacts from construction of the LPP's. Sedimentation of the marsh surface can smother marsh plants and change the substrate elevation and composition. Areas with an altered elevation and soil type may support an alternate plant species composition. If the sedimentation is severe, upland vegetation or common reed, having low wildlife value may colonize the area.

7.20 If the level of construction disturbance is minor the marsh could restore itself. In a worst case the area would need to be regraded and planted with marsh vegetation. The common reed marsh would need the least restoration and would be allowed to revegetate itself without grading unless an unforeseeable major impact occurred. If impacts to the substrate elevation of the low and high salt marsh occurred the pre-existing elevation would need to be restored.

b. Long Term Impacts

7.21 A total of about 17.7 acres of wetland would be lost to the footprints of the structures. This is broken up as follows: Lynn LPP-2.6 acres, Revere Beach Backshore LPP-6.6 acres, East Saugus LPP-7.4 acres and Town Line Brook LPP-1.1 acres. About 1.9 acres of wetlands that would otherwise be impacted by hydrologic impedance as a result of placement of the LPP structures would be served by automated tidegates to allow continued flushing as at present.

7.22 In addition to the impacts from the direct elimination of wetland from the construction of structures, vegetation along the alignments could potentially change if freshwater inflow from upland areas behind the structures was no longer allowed. Areas along the alignments dominated by competitively less salt tolerant salt marsh plants could change in dominance to more salt tolerant plants. Although this could decrease diversity it would not be considered a potentially significant impact. In fact, since the estuarine structures are to include tidegates, allowing freshwater inflow to the wetlands during non-storm periods, this effect will be practically nonexistent.

Option 2 (Nonstructural Plans)

7.23 No impacts to vegetated wetlands are expected from the Nonstructural Plans since no work in wetlands would be required.

Option 3 (Regional Saugus River Floodgate Plan)

a. Construction Phase Impacts

7.24 Construction phase impacts on wetlands from the Regional Plan may result from sedimentation during construction of the gate structure. Turbidity from construction, however, is expected to be minimal. No significant impacts on wetlands would result from the somewhat reduced cross sectional river opening during the construction period.

b. Long Term Impacts

Direct Impacts

7.25 No vegetated wetlands would be lost as a result of construction of the floodgate or any other Option 3 structures. Protection of estuarine storage area as a project feature could prevent losses due to illegal fills or other activities.

Indirect Impacts

7.26 Throughout the study process information has been collected to evaluate the indirect impacts of the floodgate. Potential wetland impacts considered included (i) reduction of salinity levels and alteration of other water quality parameters, (ii) reduction of the elevation of tidal flooding in the tidal freshwater/brackish wetlands under the gate open condition, (iii) reduction of the number of times the wetland is flooded because of gate closure, and (iv) elimination of storm extreme high tides and saline influence from outlying portions of the estuary.

i. Water Quality Changes

7.27 Changes to salinity and other water quality parameters with the project are not projected to be significant (see Water Quality Section). These changes would be well within the tolerance range of the existing vegetation; therefore, no impacts to the wetlands from water quality changes are expected.

ii. Reduction of Elevation of Tidal Flooding with the Gate

Open

7.28 The reduction of the level of tidal flooding in the tidal freshwater/brackish wetlands on a daily basis because of constriction at the gates under the gate open condition was a concern. It was felt that reduced flooding could favor less desirable species. Data on plant species composition in relation to elevation and soil type was collected to aid in projecting effects. However, continued design of the gate configuration resulted in the selected N4 gate scheme under which near ambient flushing conditions are to be maintained. Therefore, this potential impact was avoided.

iii. Reduction in Tidal Flooding Frequency with the Gate Closed

7.29 In order to determine whether there would be a reduction in the number of times the wetland is flooded because of gate closure, the marsh was observed during two projected approximately seven foot tides (the level at which gate closure would normally take place).

7.30 Actual tide levels at the Fox Hill Bridge on Route 107 were 6.5 feet and 6.8 feet NGVD. High tidal water levels were observed on December 1 and 2, 1987 relative to the wetland/upland edge in the upper Saugus River (upstream of Lincoln Ave. Bridge), Shute Brook and five points on the lower estuary. Additional observations of marsh flooding were made on August 30, 1988 in the area west of the I-95 embankment. The tide on this date was predicted to reach 6.7 feet NGVD and was actually recorded at 6.4 feet NGVD. This later observation of tide levels was conducted because a map of the flooding contour during a 6.9 foot tide suggested that much of the area west of the I-95 embankment might not be flooded; however this was found not to be the case.

7.31 These field observations have indicated that nearly the entire marsh is flooded during the 6.4, 6.5 and 6.8 foot tides. Only a few isolated areas of the marsh were not flooded during the 6.4 and 6.5 foot tides and all of the marsh observed was flooded during the 6.8 foot tide. Given the relatively flat surface of the marsh it was concluded that the entire marsh would be flooded with the additional two to six tenths of a foot of water that would be present with the seven foot tide. Thus, with the floodgates anticipated to be closed at seven feet (with the tide projected to exceed eight feet) some two to three times a year, there would be no wetland impacts by the reduction in the number of seven foot plus tides. Stated another way, operation of the floodgates for closure at seven feet would not reduce the frequency of flooding of the marsh, all of which is below the seven foot level. Gate closure could take place below seven feet under very rare circumstances related to rainfall intensity, wind direction and velocity and other circumstances. However this would be such a rare event as to not have any impact whatsoever on the average annual frequency of flooding of the marsh.

iv. Elimination of Extreme Storm Tides in the Upper Estuary

7.32 The elimination of extreme storm high tides from the upper estuary is a concern because it would reduce periodic flushes of the system with saline waters. This has the potential to affect plant species composition. According to Odum et al. (1987), marshes which intermittently come into contact with elevated water salinities may support slightly less diverse plant communities dominated by facultative halophytes. Additionally concern has been expressed for the elimination of severe storm surges that enhance detrital export. The gate closures will only occur at the top of the flood tide, at 7.0' NVGD all wetlands will be flooded. The wind-induced forces on estuarine mixing and flushing will still exist. Ebb tides will continue to export detritus. Therefore this impact is not expected to be significant.

7.33 An adverse affect on the marsh ecosystem from elimination of storm tides would occur if less desirable plant species, such as purple loosestrife (Lythrum salicaria), replaced the existing species. The potential for change

due to elimination of storm tide water levels at the Study Area would be very minimal because the flooding is so infrequent, short in duration and most often in the non-growing season.

F. Benthic Habitats

Option 1 (Local Protection Plans)

7.34 A total of 14.6 acres of intertidal habitat and associated organisms would be lost to Option 1. Another 2.9 acres of intertidal habitat would be temporarily impacted to a minor degree during construction. This is enumerated in detail below, and summarized in Table 7.1. The 2.9 acres of intertidal habitat temporarily impacted during construction would experience destruction of benthic organisms; however, these areas would likely be recolonized rapidly. Other construction impacts indirectly affecting benthic organisms would be the temporary alteration of sediment habitat and water quality. Construction of the LPPs would take two years, with concurrent construction of the four LPPs.

a. Revere Beach Backshore LPP

7.35 Approximately 3.9 acres of intertidal habitat along the Pines River would be displaced by structures under the local protection plan for the Revere Beach Backshore. Another 0.5 acres would be temporarily impacted to a minor degree during construction. This area has low to moderate densities of soft shell clams (up to $25/m^2$ in sampling for this study). However mussels were found in high numbers along the shore of the Pines River, up to over $3000/m^2$.

b. Lynn LPP

7.36 Construction of the Lynn Harbor dikes and walls on existing upland will eliminate any potential permanent impacts to intertidal habitat. Construction of dikes will result in 0.6 acre of temporary impact to intertidal habitat to establish the toe of the structures. At the same time, the removal of the existing bulkheads will result in the reclamation of 0.5 acre of intertidal flat. Additionally, the stone face of the dike, behind the portion of the existing bulkhead, will result in 0.2 acre of additional habitat below MSL and 0.4 acre of additional habitat between MSL and MHW. The intertidal area adjacent to the existing bulkheads and other shoreline structures along Lynn Harbor have a patchy distribution of soft shell clams (average density of about $50/m^2$ from sampling) and mussels (up to $100/m^2$). Along the shore of the Saugus River in Lynn approximately 9.2 acres of intertidal habitat would be permanently lost and another 1.6 acres would be temporarily impacted to a minor degree during construction. Soft shell clam densities in the Saugus River were high and ranged up to $358/m^2$.

c. East Saugus LPP

7.37 Structures along the Saugus River in East Saugus would result in the loss of 1.5 acres of intertidal habitat (see above for soft shell clam densities). Another 0.2 acres would be temporarily impacted to a minor degree during construction.

7.37A Finally, the Option 1 structures would provide new substrate for mussel attachment, once they are built.

Option 2 (Nonstructural Plans)

7.38 This option does not involve work in any intertidal or subtidal habitats. Benthic habitats will not be impacted under this option.

Option 3 (Regional Saugus River Floodgate Plan)

7.39 Implementation of Option 3 would destroy or alter (through dredging) 2.0 acres of intertidal habitat and 2.0 acres of subtidal habitat. However, of the 2.0 acres of intertidal habitat lost, 1.0 would be converted to subtidal habitat by dredging, thus resulting in a net loss of 1.0 acre of subtidal habitat. In addition, scouring due to changed velocity conditions around the floodgates would alter 1.6 acres of intertidal and 2.2 acres of subtidal habitat. Overall, 3.6 acres of intertidal and 4.2 acres of subtidal habitat would be permanently impacted. Another 0.5 acre of intertidal habitat would be temporarily impacted to a minor degree during construction and 4.5 acres of subtidal area would be dredged slightly deeper (see Table 7.1).

a. Construction Phase Impacts

7.40 Construction of all features except the floodgate would take one year, followed by floodgate construction which would take about 3 years.

7.40A Construction sequencing is described in the Main Report.

7.41 Construction activities, including dredging, would result in the direct mortality of benthic organisms. These activities would also indirectly affect benthic organisms by temporarily altering sediment habitat and water quality.

7.42 Dredging activities would be concentrated mostly at the beginning of floodgate construction. Dredging of the navigation cofferdam, temporary navigation channel and river bottom approaches to the gates would generate 78,700 cubic yards of material. Cofferdams for construction of the tainter gates and wall on the Lynn Harbor side would generate 28,400 cubic yards of material; construction of the tainter gate and wall on the Revere side would generate 7,100 cubic yards of material.

7.43 Grain size of the surficial material (top six inches) at the mouth of the Saugus River and along the Lynn Harbor shorefront is predominantly sand with less than five percent fines (<0.063 mm). A few borings performed at the MDC fish pier show that the subsurface materials vary from silty clay to fine

Table 7.1 Summary of Benthic Habitat Impacts

Benthic Habitat Impacts Under Option 1 (in acres)

	Intertidal Lost	Subtidal Lost	Temporary Construction Impacts to Intertidal
Revere Beach Backshore LPP	3.9	--	0.5
Lynn LPP	9.2	--	2.2
East Saugus LPP	1.5	--	0.2
TOTAL IMPACTED	14.6	--	2.9

Benthic Habitat Impacts Under Option 3 (in acres)

	Intertidal Permanently Impacted	Subtidal Permanently Impacted	Temporary Construction Impacts to Intertidal	Temporary Construction Impacts to Subtidal
<u>Floodgate</u>				
Footprint-lost	0.3	1.9	--	--
Dredging-lost	1.0	(1.0 gain)	--	4.5 (deepened)
Scour-altered ¹	1.6	2.2	--	--
Lynn Harbor-lost	0.0	0.1	0.6	--
Lynn Harbor-gained (0.5)	(0.5)	--	--	--
Point of Pines-lost	0.7	--	2.7	--
TOTAL LOST	2.0	2.0	--	--
TOTAL GAINED	0.5	1.0	--	--
NET LOSS	1.5	1.0	--	--
TOTAL IMPACTED ²	3.6	4.2	3.3	4.5

¹ Based on 300 feet (per side) of scour outside gates.

² Excludes gain

sands. Dredging this material would likely result in localized and temporary increases in suspended solids concentration. Most of the material would settle within a few minutes (estimated fall velocities are greater than 0.01 cm/sec). The finer material would be expected to stay in suspension for longer periods of time. The material that could be expected to become resuspended would not be expected to contribute significantly to the suspended solids load of the estuary.

7.44 Background turbidity levels in the Saugus/Pines Rivers Estuary range from 10 to 30 mg/l. Suspended solids concentrations around dredging activities are typically 300 to 1000 mg/l, depending on the type of dredge used and environmental conditions. Suspended solid concentrations drop off rapidly with distance and can be expected to approach background concentrations within 500 meters of the dredging activity.

7.45 Dredging activity would not significantly impact benthic organisms in the area. Most estuarine organisms are tolerant of short-term increases in suspended solids and the quantity of material released is unlikely to cause significant mortality due to burial. Most of the areas of high benthic abundances and high shellfish concentrations are greater than 500 meters from the dredging area.

7.46 Cofferdams would be built to provide a dry working environment for much of the necessary excavation work at the floodgate structure; thus, this work would occur without any further impacts on the benthic environment.

7.47 The area temporarily impacted by dredging during construction (subtidal habitat would be dredged slightly deeper) amounts to 4.5 acres. This area would be quickly recolonized, replacing lost organisms.

7.48 0.6 acres of intertidal habitat temporarily impacted along Lynn Harbor and 2.7 acres of intertidal habitat temporarily impacted (by beach nourishment) at Point of Pines would experience destruction of benthic organisms. However, these areas would likely be recolonized rapidly.

b. Long Term Impacts

7.49 Five alternative floodgate alignments in the general area of the Saugus rivermouth were considered during the study with Alignment 2 being selected (see Main Report). The amount of subtidal and intertidal habitat lost from the five alternative floodgate alignment footprints is shown in Table 7.2. The Alignment 5 footprint results in the greatest loss of intertidal habitat. Other Alignments (1, 2, 3 and 4) are roughly comparable in the amount of intertidal habitat lost. Benthic sampling identified the confluence of the Saugus and Pines Rivers as an area of shellfish concentrations ranging from 25 to 58 Mya/m^2 with concentrations at the mouth of the Saugus River ranging from 3 to 17 Mya/m^2). Alternative Alignments 3, 4 and 5 are closer to the confluence; construction of one of these Alignments could result in loss of higher density shellfish habitat than Alignments 1 or 2. Thus, the selected Alignment 2 is preferred from this point of view. The floodgate structure at Alignment 2 would displace approximately 1.4 acres of intertidal and 1.6 acres of subtidal habitat. The intertidal habitat on the Lynn side of the river is

clam and mussel habitat. Dredging associated with the finished grading would change 1.0 acres of intertidal to subtidal habitat. Inspection of this area revealed a large (0.8 acre) mussel bed. Scouring due to changed velocity conditions could impact 1.6 intertidal acres and 2.2 subtidal acres.

Table 7.2 Benthic Habitat Displaced by Footprint of Option 3 Floodgate Alignment Alternatives

	<u>Intertidal (acres)</u>	<u>Subtidal (acres)</u>
Alignment 1	0.3	1.9
Alignment 2	0.3	1.9
Alignment 3	1.2	2.0
Alignment 4	1.4	1.6
Alignment 5	2.2	1.0

7.50 Along Lynn Harbor no intertidal habitat would be permanently displaced by the structures. The revetment at Point of Pines would result in the loss of 0.7 acres of intertidal habitat.

7.51 A soft shell clam density of $50/\text{m}^2$ is considered to be a reasonable representation of the overall impacted areas for the Regional Saugus River Floodgate Plan. Mussel densities sampled in the areas to be impacted by the Regional Saugus River Floodgate Plan structures were up to $100/\text{m}^2$, however much higher densities have been reported near the mouth of the estuary.

7.52 Alteration of intertidal flats by scour and sedimentation would impact the nature of the benthic communities in these locations. Benthic community structure in any given area would change to relate to the changed nature of the substrate. Recruitment would take place from nearby similar substrate. About half of the 1.6 acres of intertidal habitat affected by scour is known to be clam and mussel flat. Alterations in sediment substrate associated with the scour may actually prove beneficial to filter feeders such as clams or mussels.

7.53 Results of the Water Quality Analysis indicate that the floodgate would have no significant impact on tidal volume, tidal flushing or water quality of the Saugus and Pines Rivers Estuary and therefore no related impacts on the benthos would be anticipated.

7.54 Finally, structures that are part of Option 3 would provide new substrate for mussel attachment, once they are built.

Summary of Benthic Impacts

7.55 The nonstructural plan (Option 2) would obviously have the least amount of impact to benthic organisms. In terms of total acreage affected, the floodgate plan would have less impact on benthic habitats than the local protection plans. Also, the local protection plans would impact some high

density shellfish beds in the Saugus River. With floodgate Alignment 2 and the N4 gate scheme the floodgate plan could be constructed and operated with relatively minor impacts to the benthic community.

G. Sandy Beaches

Option 1 (Local Protection Plans)

7.56 Option 1 would include the raising of 0.3 miles of existing seawalls by two feet at the north end of Revere Beach. This construction would temporarily disrupt recreational activity on a portion of Revere Beach. No dune or beach vegetation would be disturbed because development along Revere Beach has precluded the establishment of a barrier beach ecosystem. Construction interference with beach use periods would be minimized as much as possible.

Option 2 (Nonstructural Plans)

7.57 This option would have no impact on sandy beaches in the Study Area.

Option 3 (Regional Saugus River Floodgate Plan)

7.58 Floodgate Alignments 1, 2, and 3 of the proposed plan would affect sandy beaches at Point of Pines. The location of floodgate alignment 1 would cause currents to run faster along Point of Pines possibly increasing erosion of the Point of Pines dunes. Increased erosion should not occur with Alignments 2 or 3. All of the above alignments would transect the Point of Pines beach.

7.59 Alignment 2, the preferred alignment, would permanently displace less than one tenth of an acre of sandy beach (from the seawall to mean high tide) along the Saugus River stretch of Point of Pines.

7.60 The revetment to be built from Carey Circle to Alden Avenue along the Point of Pines shorefront would permanently displace about another 0.1 acres of sandy beach.

7.60A Approximately six acres of new beach would be constructed to (a) reduce the cost of disposing of sand from under the dunes between Alden Avenue and the seawall and (b) offset about 0.2 acres of beach lost. Sand dunes displaced by revetment construction between Alden Ave. and the seawall would be restored and protected through dune grass plantings, construction of crossovers over the dunes at the end of each street and protective fencing.

7.61 The construction work would be accomplished over a one year period. Some disruption of recreational activity on the beach would occur during construction, however construction interference with beach use periods would be minimized as much as possible.

H. Artificial Shorelines

Option 1 (Local Protection Plans)

Construction Phase Impacts

7.62 The new structures proposed under Option 1 would in some areas, replace current structures and temporarily displace the associated organisms. Species dependent on these organisms as foraging material will be required to seek alternative areas for feeding until construction is complete and the area is repopulated. Estuarine species such as barnacles, algae, mussels and periwinkles will recolonize the new flood control structures.

Long Term Impacts

7.63 Once construction is complete, currents can carry larvae from nearby spawning marine organisms to the new flood control structures. Completing construction in spring, before the spawning of most marine species, would quicken the recolonization process. Larvae can then settle and reestablish their current populations on the artificial shoreline. This intertidal population should be able to resume current population density within five years. Blue mussels can attain full growth in two to five years in less than prime habitats (Gosner, 1978) and newly constructed rock jetties in California were found to contain estuarine species in two years (Reish, 1969). Therefore, no long term impacts to species populating artificial shorelines are anticipated.

Option 2 (Nonstructural Plans)

7.64 No impacts to artificial shorelines and their associated flora and fauna are anticipated from Option 2.

Option 3 (Regional Saugus River Floodgate Plan)

7.65 Option 3 would require about 9000 feet of dikes and walls along Lynn Harbor.

Construction Phase Impacts

7.66 Construction impacts to organisms populating the Lynn Harbor structures would be similar to impacts described for Option 1. Species inhabiting the present Lynn Harbor shorefront structures will be temporarily displaced during construction as well as species dependent on these organisms for foraging material. This temporary displacement will be offset by the construction of Option 3 shorefront structures which can provide additional sites for estuarine species to settle.

Long Term Impacts

7.67 Once construction is complete, currents can carry larvae from nearby spawning marine organisms to the new Option 3 structures. The larvae would be able to settle and reestablish their current populations on the new

structures. This intertidal population should be able to resume current population density within several years, as described for Option 1. No long term impacts are anticipated.

7.68 Organisms attached to existing rock along the southern shore of Point of Pines would be permanently displaced by new rock revetment and the placement of sandfill at the foot of the new revetment. Existing rock along about 700 feet of shoreline would be impacted in this way. The amount of area displaced and density of intertidal organisms inhabiting these rocks is not considered significant. It would be compensated by the available substrate on the new Option 3 floodgate and Lynn Harbor structures nearby, to the north.

I. Fish

Option 1 (Local Protection Plans)

a. Construction Phase Impacts

7.69 Because much of the work would be conducted near upper tide levels, and because proper sediment control measures would be employed, exposure of fish to suspended sediments during construction would be minimal. Construction activity in upper portions of the estuary (i.e. the Lynn and East Saugus LPPs) has the potential to impact spawning runs of anadromous species during April through June (alewife, blueback herring, rainbow smelt, shad). Activities during the spring and early summer would also expose planktonic eggs and larvae to elevated suspended sediment levels. Work in Lynn Harbor and the lower Pines and Saugus Rivers during March and April could impact winter flounder spawning. Peak densities of fish nearshore in Lynn Harbor, the lower Saugus River, and presumably elsewhere in the Saugus Estuary apparently occur from September through November (Raytheon, 1974). Activities during this period could impact these resources.

b. Long Term Impacts

7.70 Construction of dikes and flood walls in Lynn Harbor and the Saugus Pines Rivers Estuary would result in the loss of about 14.6 acres of intertidal, and 17.7 acres of vegetated wetland habitat. Fish species most severely impacted by habitat loss would probably include resident species such as Atlantic silverside, inland silverside, mummichog, and striped killifish, and juveniles of species which utilize the estuary as a nursery.

Option 2 (Nonstructural Plans)

7.71 This option would have no foreseeable short or long term impacts on the fisheries resources of Lynn Harbor or the Saugus/Pines Rivers Estuary.

Option 3 (Regional Saugus River Floodgate Plan)

a. Construction Phase Impacts

7.72 Some increases in suspended sediment levels and sedimentation would be likely to occur during construction of the Option 3 structures. Because much

of the work would be conducted near upper tide levels, and proper sediment control measures would be employed, exposure of fish to elevated suspended sediment levels and sedimentation would be slight.

7.72A Construction activities during the spring and early summer would expose planktonic eggs and larvae to elevated suspended sediment levels. Work during

March and April could impact winter flounder spawning. Peak densities of fish nearshore occur from September through November. Activities during this period could impact these resources.

7.73 At all times during floodgate construction a sufficient flow area (minimum 5,200 square feet of cross sectional river opening below MSL) would be maintained in the Saugus River to allow passage of fish eggs, larvae and adults into and out of the estuary. Predicted maximum average currents during a mean tide range during construction would be about 2.9 fps or roughly twice that of existing conditions at the General Edwards Bridge (1.4 fps), but should not significantly interfere with fish movements into and out of the estuary. Maximum average currents during a mean spring tide range would be about 3.4 fps vs. an existing 1.7 fps at the General Edwards Bridge. Fish swimming speeds are discussed in paragraphs 7.79-7.84.

7.74 Fish in the vicinity of the floodgate during dredging operations would be exposed to elevated concentrations of suspended solids. No significant impacts due to dredging operations are anticipated because fish are capable of avoiding dredging (e.g. Moore et al., 1977), and are generally tolerant of short term exposure to relatively high levels of suspended sediments (Stern and Stickle, 1978). Surficial sediments are sands with low silt content, and unless substantial quantities of clay are dredged from underlain sediments, the area impacted by high concentrations of suspended sediments would be small. Among species occurring in the area, Atlantic silversides are probably among the most sensitive to suspended solids (Stern and Stickle, 1978). Laboratory studies indicate that lethal (24 hr-LC10) concentrations of suspended solids for this species are 580 mg/l. Concentrations of this magnitude are likely to occur only in the immediate vicinity of the dredge, and thus have no potential to have an overall impact on the Atlantic silverside population in Lynn Harbor or the Saugus River. Dredging activities could avoid the March-April spawn of winter flounder, spring runs of anadromous and catadromous species, the spring and summer high egg and larval densities in the water column, and peak fall season densities of fish in the area. Dredging impacts on fish could be minimized by restricting dredging to a November through February timeframe.

b. Long Term Impacts

(i) Effects of Floodgate Structure on Fish Passage

7.76 The maximum average current velocities expected to occur with the construction of the floodgate for gate schemes FC, N1, N2, N3 and N4 would be greater than the maximum average velocity that was measured at the center of the channel at the General Edwards Bridge for a mean spring tide condition. Maximum average velocities for the various schemes vary with the degree of

constriction imposed. Maximum average spring velocities associated with scheme EN would be about the same as existing conditions at the General Edwards Bridge (1.7 fps). Maximum average spring velocities for the other schemes would range from about 2.1 fps for the selected scheme N4 to 10.8 fps for scheme FC. It should be noted that these maximum average velocities occur during peak tidal flow (around mid-tide). When the tide level is closer to high or low tide, the current velocities would be lower. For the selected gate scheme N4 the maximum average velocity during a mean (as opposed to mean spring) tide range would be 1.7 fps, similar to existing currents in the proposed gate location.

7.77 The precise impact of velocity changes on the fishery resources utilizing the Saugus/Pines Rivers Estuary is difficult to quantify; some perspective is offered in the following paragraphs.

7.78 Any impact of the floodgate on fish passage would be most critical to anadromous and catadromous species which must enter the estuary in order to complete their life cycle. Anadromous species occurring in the estuary include rainbow smelt, alewife, blueback herring, American shad and sea run brown trout. The American eel is the sole catadromous species utilizing the estuary.

7.79 The ability of fish to overcome potential increases in velocities caused by a floodgate depends on their swimming speed. Swimming speeds depend on species, age and ambient environmental conditions (i.e. oxygen concentrations and water temperature).

7.80 Fish swimming speeds are classified in three categories: cruising speed, sustained speed, and darting speed. Cruising speed is considered the speed which a fish may maintain for extended periods, on the order of hours, and is utilized for general movement. Sustained speed may be maintained for minutes and is employed for passage through turbulent areas or negotiating obstructions. Darting speed is a single, unsustainable effort on the order of 5-10 seconds and is used in predation or for escape. Typically, a fish's cruising speed is on the order of 15-20 percent of its darting speed (Bell, 1986). For the adult anadromous species: brown trout and American shad sustained speeds range from 3-7 fps; sustained speeds for adult herring range from 3-5 fps; sustained swimming speeds of rainbow smelt and alewife are not available, but are likely to be similar to that for herring.

7.81 These data suggest that velocities in the vicinity of the floodgate of up to about 3-5 fps would not impact movements of anadromous species. Possible slightly increased currents generated by the selected gate scheme N4 should have no significant impact on passage of these fish.

7.82 Cruising speeds of American eel adults are documented at over 3 fps and sustained speeds are likely to be around 5 fps. Downstream migrating adults should thus have no difficulty in navigating through the flood gate under scheme N4. Young eels (elvers) probably have somewhat slower swimming speeds and might increasingly enter the estuary during slack or flood tides.

7.83 There is little information available concerning the relative swimming speeds of other species which inhabit the Saugus/Pines Rivers Estuary. It is expected that the cruising speed of winter flounder would be similar to that reported for plaice (1-2 fps). Sustained speed for plaice is unknown, but is probably at least twice that of cruising speed. Cruising speed for cod is 1-3 fps. It is likely that similar swimming speeds would be observed for tomcod and hakes. The sustained speed for mackerel ranges from 6-10 fps, making it among the fastest of the local species. Similar sustained speeds would be expected for menhaden and bluefish. The remaining common indigenous species include the anchovy, killifishes, silversides and sticklebacks. Reported darting speed for the stickleback is 3 fps, which would suggest a cruising speed of less than 1 fps. Anchovy cruising speed ranges from 1-2 fps.

7.84 Based on this information, it is unlikely that passage of most of the above species would be impeded by the possible slightly increased currents near the proposed floodgate under gate scheme N4. The gates were sized so that currents following construction would approximate the existing currents at the mouth of the estuary. Possible exceptions include small forage species including sticklebacks and small juveniles of other species. Because these fish would still be able to pass through the floodgate with prevailing tidal currents and during slack tides, no deleterious impact is expected.

7.85 The floodgate would not obstruct passage of demersal species because all tainter gate openings (500 linear feet) would be essentially flush with the bottom of the Saugus River, or where topographic features will not permit this, will have rock/cobble bottom slopes constructed. The 18" vertical bottom sill on the 100 foot wide navigation gate with a concrete ramp on the river side only would be very unlikely to inhibit demersal fish passage.

7.86 Pelagic species normally approach an obstruction within a limited depth range. For adult salmonids, fish occur from the surface to a depth of 12 feet, but are most concentrated between depths of 2-6 feet (Bell, 1986). Similar behavior may also occur in other pelagic fish species common to the Saugus/Pines Rivers Estuary (i.e. herring, shad, menhaden, alewife, smelt and bluefish). For gate scheme N4, the tops of tainter gate openings would be about five feet below the water surface at mean high tide. Given a maximum swimming depth of 12 feet, tainter gates would not be expected to provide an obstruction to passage of pelagic fish. Surface waters at MLW would be below gate tops and pose no potential obstruction. Passage of pelagic fish through the 100 foot wide navigation gate will be unobstructed at all tide levels.

7.87 It is possible that turbulence in the vicinity of floodgates could somewhat slow passage of migrating fish by eliciting avoidance or hesitation behavior. This potential impact has been minimized by reducing turbulence through the use of large gates and the placement of rounded edges on gate abutments.

7.88 Given the anticipated low frequency and short duration of gate closures, these events should have no significant impact on fish movements into and out of the estuary. Gate closures would occur rarely during the important spring runs of anadromous species (April through June).

(ii) Ichthyoplankton Transport

7.89 Because a large percentage of the planktonic eggs and larvae which occur within the estuary during the spring and fall are transported into the estuary from Lynn Harbor, the impact of the proposed floodgate on estuarine ichthyoplankton must be considered. Ichthyoplankton would encounter shear acceleration at the navigation and flushing gates as water flow is constricted. Acceleration forces would also develop as a result of the turbulent eddies at the gate openings. Ichthyoplankton caught in such eddies could be damaged as a result of the shear stresses within the eddies or by direct impingement on the walls of the gate structure.

7.90 Nothing is known concerning the impact of shear stress caused by floodgates or similar structures on fish eggs and larvae under natural conditions. Morgan et al. (1974) examined shear stress damage to striped bass and white perch (Morone americana) eggs and larvae under laboratory conditions. It can generally be assumed that the ichthyoplankton of the Saugus/Pines Rivers Estuary would show similar values. It is suggested that the shear stress impacts on ichthyoplankton would be negligible because the major eddies would likely occur only during limited periods (i.e. high tides) and because utilization of relatively large gates will minimize potential impingement during passage. The utilization of rounded edges on gate abutments would reduce turbulence and help minimize shear stress.

(iii) Habitat Related Impacts

Floodgate Vicinity

7.91 Option 3 would destroy 3.0 acres of intertidal and subtidal habitat. Increased scour would occur on 3.8 acres. Habitat loss and scour and sedimentation would impact prey (benthic invertebrates) of finfish communities. Among finfish, demersal species would be most severely impacted. Winter flounder is the predominant demersal species in the area. Adults occur on substrates ranging from silty sand to gravel or pebbles (Bigelow and Schroeder, 1953), and they would probably continue to inhabit most of the area impacted by the floodgate. Spawning occurs primarily on sands or silty sands. Although some winter flounder spawning may occur near the proposed floodgate, strong currents exist in this area, and it is probably not preferred winter flounder spawning habitat (D. Chadwick, Mass. Div. of Marine Fisheries, 1988 - Pers. Commun.; B. Chase, Mass. Div. of Marine Fisheries, 1988 - Pers. Commun.). The floodgate would probably reduce winter flounder spawning in areas subject to increased scour, but might enhance spawning success in some areas near the proposed gate where currents would be reduced. Overall, the floodgate would be unlikely to significantly impact winter flounder spawning in the Saugus/Pines Rivers Estuary and Lynn Harbor.

Saugus/Pines Rivers Estuary

7.92 Normal operation of the floodgate (Alignment 2, N4) would be unlikely to have a significant impact on existing fisheries habitat within the estuary.

7.93 During gate open conditions, alterations in current velocity would be limited to within several hundred feet of the floodgate. Within this area some changes in fish community composition might occur, with smaller forage species (e.g. atlantic silversides) and juveniles becoming less abundant. Because tidal exchange would be largely unaffected during gate open conditions, the floodgate should have no impact on water quality parameters (i.e. salinity, dissolved oxygen levels, heavy metals, temperature) which could affect fisheries resources in the estuary. Tidal levels in upper reaches of the estuary, which is of critical importance as spawning habitat for anadromous species, would be largely unaffected. The expected reduction in the frequency of tides above el. 7 feet NGVD should not have a deleterious impact on fisheries resources.

7.94 No significant habitat impacts would be attributable to closed gate conditions. The minor and temporary water quality changes during closure should not have any significant deleterious effects on fisheries in the estuary.

7.95 Some impacts to fisheries habitat in the estuary could occur over the very long term as a result of decreased flushing of finer sediments by large storm tides. The significance of this impact is very difficult to evaluate however, since nothing is really known concerning the importance of these events to the sedimentology of the Saugus/Pines Rivers Estuary. Species which could be impacted by decreased long term flushing of the estuary would be those which spawn demersal eggs on sandy or gravelly substrates (i.e. alewife, blueback herring and winter flounder).

J. Lobsters

Option 1 (Local Protection Plans)

7.96 The local protection plans would have no significant impact on lobsters in the Study Area. No subtidal lobster habitat would be impacted by this option.

Option 2 (Nonstructural Plans)

7.97 This option would have no significant impact on lobster populations in the Study Area. No subtidal lobster habitat would be impacted by this option.

Option 3 (Regional Saugus River Floodgate Plan)

a. Construction Phase Impacts

7.98 Construction of the proposed floodgate would involve the destruction of 2.0 acres of subtidal habitat, however 1.0 acres would be regained from dredged intertidal habitat. Approximately 4.5 acres of subtidal habitat would be dredged slightly deeper. Any lobsters present in the impacted areas would likely be destroyed. Lobsters in the vicinity of dredging operations would be exposed to elevated concentrations of suspended sediments. Some of the work would be conducted under dry conditions, using cofferdams, thereby reducing this impact. Adult lobsters are quite tolerant of suspended sediment (Stern

and Stickle, 1978), and should not be significantly affected by brief exposure to elevated concentrations of suspended sediments. Any dredging-related impacts to lobsters would probably be greatest during molting, which occurs most frequently in early spring and early fall (Cobb, 1976). Construction of proposed floodwalls and dikes along the Lynn shorefront will occur in or near intertidal areas, and should have no impact on lobsters.

b. Long Term Impacts

7.99 Construction of the floodgate would eliminate 1.0 acres of existing subtidal habitat. An additional 2.2 acres of subtidal habitat near the tainter gates would be subject to scour. These areas are only incidental habitat for use by lobsters. Some new good quality lobster habitat would be provided by the stone apron placed along both sides of the navigation and tainter gates, and by stone protection along the floodgate dike.

7.100 The floodgate would have no significant impact on lobsters inhabiting the Saugus and Pines Rivers. The selected floodgate design (N4) should not have a significant impact on the movements of lobsters into and out of the Saugus/Pines Estuary. The design provides 600 linear feet of gated openings (ten 50 foot wide tainter gates and one 100 foot wide navigation gate). Lobsters should have no difficulty passing, in either direction, through the tainter gates. Gate openings would be flush with the river bottom or have rock/cobble bottom slopes where topographic features will not permit this, and be designed in such a way that tidal scour would not eventually produce a ledge too high for lobsters to negotiate. The 100 foot wide opening provided by the navigation gate would, with an 18 inch vertical bottom sill within the gate, and a concrete ramp on the riverside only, pose a barrier to lobsters moving into the estuary (lobsters are unable to negotiate a vertical obstacle greater than 1/2 to 2/3 their length (S. Cobb, University of Rhode Island, 1988-Pers. Commun.)). Lobsters contacting floodgate dikes, gate abutments, or the vertical navigation gate sill are expected to move laterally, and successfully cross at the tainter gates. Overall, the gate openings should be sufficient to allow normal seasonal movements of lobsters into and out of the estuary.

7.101 Minor anticipated changes in estuarine water quality during open gate and closed gate conditions would have no significant impact on lobsters in the Saugus and Pines Rivers.

K. Wildlife

Marine Mammals

a. Option 1 (Local Protection Plans)

7.102 Harbor Seals occasionally use the Saugus and Pines Rivers from late September to late May (SES, 1986). The White-sided Dolphin may be seen foraging close to shore on migratory fish from late fall to early winter (Beach, 1988).

7.103 With the use of proper erosion control practices during construction, turbidity should not significantly affect fish, shellfish and squid, food resources of these marine mammals. Increased noise during construction of the dikes and walls would deter use of the area by the Harbor Seal and White-sided Dolphin temporarily.

7.103A Option 1 would have long term impacts through the destruction of wetlands and intertidal habitat. This degradation reduces availability of potential foraging areas to animals low on the estuarine food web, thus impacting food resources for marine mammals.

b. Option 2 (Nonstructural Plans)

7.104 Option 2 would not impact marine mammals in any way.

c. Option 3 (Regional Saugus River Floodgate Plan)

7.105 Temporary construction impacts to food resources would be minimal. Increased noise during construction could temporarily keep marine mammals away from construction areas.

7.106 The floodgate would deter the Harbor Seal from traveling up the Saugus and Pines Rivers, thus limiting the accessibility of shellfish resources. Therefore, the alignment furthest upstream (Alignment 5) would have the least impact on use of the area by Harbor Seals. The difference between Alignment 2 (the preferred Alignment) and Alignment 5 (the furthest upstream) is approximately 1300 feet. Several mussel patches are located along this 900 foot strip. This reduction in available foraging area is not significant considering that the estuary affords only occasional use by the Harbor Seal. Fish, shellfish and squid would be available downstream of the floodgate as at present. Option 3 would have no effect on use of the Study Area by the White-sided dolphin. Protection of the estuarine storage area as a project feature could beneficially impact food sources for marine mammals.

Mammals, Reptiles and Amphibians

a. Option 1 (Local Protection Plans)

7.107 Temporary construction impacts to food resources would be minimal. Increased noise during construction could cause avoidance of construction areas.

7.108 The long term impacts of Option 1 on mammals, amphibians and reptiles in the Study Area would be significant with the construction of 8.8 miles of structures (six miles within the estuary). Especially impacted would be those species (such as Red Fox, Cottontail Rabbit, Raccoon and Opossum) which utilize the highly productive wetland/upland transition or ecotone where many of the structures would be located. The Red Fox and Cottontail Rabbit, typically terrestrial species, may utilize wetland or transition habitat because of a lack of upland habitat in the Study Area. The destruction of 17.7 acres of wetlands and 14.6 intertidal acres would impact habitat, much of which is potential foraging area. In addition, a reduction of estuary habitat

reduces the buffering capability of this sizable wetland which affects those species inhabiting the interior portions of the wetland due to a low tolerance for human interaction.

b. Option 2 (Nonstructural Plans)

7.109 Option 2, the non-structural alternative would have no impact on the mammals, reptiles and amphibians of the Study Area.

c. Option 3 (Regional Saugus River Floodgate Plan)

7.110 Temporary construction impacts to food resources would be minimal. Increased noise during construction could cause avoidance of construction areas.

7.111 Option 3 would eliminate 2.0 intertidal and 1.0 subtidal acres, most of which would not be potential foraging area for mammals, reptiles and amphibians. Option 3 would have no significant effect on mammals, reptiles and amphibians due to the floodgate as changes to existing wetland vegetation, water quality, velocities, hydrology and available food resources are not expected to be significant. Protection of the estuarine storage area as a project feature would be a beneficial effect of Option 3.

Birds

a. Option 1 (Local Protection Plans)

7.112 Temporary construction impacts to food resources would be minimal. Increased noise during construction could cause avoidance of construction areas.

7.113 The combination of habitat types: tidal freshwater wetlands, tidal flats, regularly flooded salt marsh and the high salt marsh in the Saugus and Pines Rivers Estuary support a wide diversity of birds. With the loss of wetlands and intertidal flats of about 32 acres in Option 1, birds, such as the herons, ducks, and shorebirds, which forage in the mud flats for mollusks, crustaceans and polychaetes would have a more difficult time satisfying the sometimes critical energy demands of raising nestlings, migrating or wintering. Those species of birds utilizing the highly productive wetland/upland transition would be impacted by the habitat lost to the several miles of structures in that zone.

b. Option 2 (Nonstructural Plans)

7.114 Option 2 would have no significant impact on birds in the Study Area.

c. Option 3 (Regional Saugus River Floodgate Plan)

7.115 Temporary construction impacts to food resources would be minimal. Increased noise during construction could cause avoidance of construction areas.

7.116 Under Option 3, intertidal habitat losses would reduce from about 32 acres from Option 1 down to 3 acres thereby reducing the impacts to species which forage in these areas.

7.117 Floodgate alignment has important implications for Black Ducks wintering in the project area. Alignments 3 and 4 in particular would impact preferred feeding sites under and around the General Edwards Bridge, permanently eliminating these valuable intertidal flats. Black Ducks strongly attach to wintering areas and the area under and around the bridge is particularly important to Black Ducks wintering in the Saugus and Pines Rivers Estuary because it seldom freezes. Floodgate alignments which least impact Black Duck foraging areas are Alignments 1, 2 and 5. Current velocities would not increase significantly as a result of the floodgate, so no hinderance of feeding activity around it would be expected. Destruction of mussel beds, where Black Ducks feed, would be mitigated by allowing mussels to colonize the floodgate structure and/or dikes.

7.118 The operation and maintenance of Option 3, including the floodgate, is not expected to change the functioning of the coastal wetland system significantly and therefore would not significantly affect use of the estuary by avian species. Protection of the estuarine storage area as a project feature would beneficially impact the avian component of the estuarine ecosystem. Wintering Black Ducks feed for a few to several days each month at the higher high tides in the upper marsh on snails which hibernate at the base of marsh vegetation. Generally, predicted spring tides (the highest tide during the month) are approximately 7 feet. In order to provide flood protection, the floodgate would be closed at approximately 7 feet, but only when tides are predicted to be 8 feet or higher. It is estimated that the floodgate would be closed 2 to 3 times per year; the majority of those times would occur between the months of mid-October and mid-February. It does not appear that the infrequent closure of the floodgate during these times would significantly affect the Black Duck's opportunity to access the high marsh.

L. Rare, Threatened and Endangered Species

7.119 Of the fauna and flora in this category, the Study Area supports only occasional transient or migratory birds, such as the Peregrine Falcon, which may temporarily stop to feed or rest. None of the three project options would have any significant impact on these species.

M. Social and Economic Factors - Introduction

7.120 For the purposes of this section, the order of presentation for each alternative shall be Option 1, Option 3, and Option 2. The socioeconomic impacts to the area are similar for Option 1 and Option 3. This is because they are designed for similar degrees of flood stage reduction. Thus, rather than repeat the material described for Option 1 in each section for Option 3, it should be assumed that the impacts are the same unless specifically differentiated. Most of the significant differences between Option 3 and Option 1 are related to the construction impacts.

7.121 The floodproofing of buildings (Option 2) would have little overall socioeconomic impact on the study area. There would be some increase of property values surrounding the improved structures. It would do nothing to change development patterns in the area. The construction impacts would be site-specific and of short duration (six months to a year to renovate a structure). Traffic would be disrupted within neighborhoods and noise levels would be increased as with any construction project.

N. Land Use

Option 1 and Option 3

7.122 In order to assess the potential for induced development given the construction of the Saugus/Pines River flood stage reduction measures, the Study Area has been separated into three environments containing undeveloped lands, namely, 1) the wetland resources, primarily comprising estuarine salt marsh (virtually no undeveloped lands exist in this environment along the coastal shorefront), 2) land between the wetland resources and the upland limit of the FEMA A-Zone or 100-year floodplain, and 3) between the 100-year floodplain and the Standard Project Northeast (SPN) limit.

7.123 There are two primary factors which presently inhibit development within the 100-year floodplain: (1) The Wetlands Protection Act (recent designation of the Rumney Marshes Area of Critical Environmental concern (see Appendix I, Page D-35) requires additional wetland regulation through the Wetlands Restriction Program and higher water quality standards) and the Corps of Engineers/EPA Clean Water Act permit requirements place severe limitations on any activity within the wetland resources environment, of pertinence in this case being the salt marsh where development is essentially precluded by the regulations; (2) The FEMA regulations (as administered through local floodplain zoning bylaws and the State Building Code requirements for building in flood hazard areas) increase construction requirements, and hence, costs to buildings built within the FEMA 100-year floodplain, which encompasses just 121 developable acres.

7.124 Between the FEMA 100-year floodplain and the SPN flood elevation, there are no relevant regulatory impediments to construction. The only constraints would be the result of perceived flooding threats. This factor would be of a very minor priority were this to be incorporated into a business decision to develop an area. Most importantly, there is little remaining developable land (116 acres) within the region between the 100-year and SPN floodplains.

7.125 The inducement to construction in the marsh resulting from project implementation would be negligible due to acquisition of the estuary storage area and the strict regulations under the Wetlands Protection Act, Coastal Wetlands Restriction Act, and Corps of Engineers/EPA Clean Water Act permit requirements. Construction in the 100-year floodplain is presently not prohibited, but is more costly due to building code requirements. If the regulated floodplain were eliminated from the upland areas, there would be a minor economic incentive (lower construction cost) for development. Two things make this incentive relatively insignificant. First, other economic factors (interest rates, demand, etc.) outweigh reduced construction costs for

deciding whether to build. Second, the scarcity of building sites in the 100-year floodplain shown by the developable lot study (268 residential, 43 industrial, 63 commercial) in a total of 121 acres means there would be relatively little change. Most significantly, all of these sites are developable now. Similar reasoning would apply between the 100-year and SPN levels.

7.126 Stated another way, without the proposed project, development within the marsh is essentially precluded by regulation (although illegal filling continues to some degree). Without the proposed project, development will continue within the floodplain as long as it is economical and the land is available. The proposed project options would not change the controlling factors outside of the marsh, which appear to be land availability and the general economic climate, and would not change the regulatory protection of the marsh itself. It is therefore concluded that the protection afforded against flooding by the project options would not lead to any induced development within the marsh or the floodplain.

7.127 In fact, acquisition of the estuary storage area, increased monitoring and improved enforcement of existing regulations, including hiring an Environmental Enforcement Manager and education of all pertinent interests, would be required of the project sponsors, with support of the Federal agencies, to assure protection of the natural estuarine storage area under Option 3, the Regional Plan.

Option 2

7.128 As this will affect about seven percent of the buildings in the Study Area and only concern existing buildings, it would have no significant impact to land use in the area.

P. Business and Industrial Activity

Option 1 and Option 3

7.130A Under Option 1, the General Electric River Works could require shutting down portions of the plant during construction of the close to 30 tide gates needed on existing intake or discharge pipes along the Saugus River.

7.131 Master plans for all communities within the Study Area have urged redevelopment and upgrading of the built environment. Little information is available that considers development potential should flooding be reduced.

7.132 The commercial lobster and fishing industries would benefit considerably from the floodgate. By necessity, all their operations are situated in high-hazard proximity to the water. These operations and the fishing vessels themselves would be afforded protection under Option 3.

Option 2

7.133 No significant impact is anticipated.

Q. Employment

Option 1

7.134 This option would generate a number of construction jobs. On average, the project would require 100 workers per day during the two year course of construction. Beyond the construction phase of this project, there would be sporadic maintenance work created.

Option 3

7.135 As with Option 1, the project would generate primarily construction jobs. On average, about 100 workers per day would be required for about four years. Maintenance employment would be sporadic.

Option 2

7.136 Floodproofing of structures would create site-specific construction and engineering employment.

R. Population and Community Growth, Including Displacement

Option 1 a. d Option 3

7.137 No information is available to quantify the change in population or community growth should the flood damage reduction project proceed. Options 1 and 3 would involve no displacement of residents because of the location of the various components of the project and small area requirements.

Option 2

7.138 Floodproofing of existing buildings would have no impact on population and community growth.

S. Public Facilities and Services

Option 1 and Option 3

7.139 Aside from elimination of potential flood damage costs, the most significant impact of the flood reduction measures would be the reduction of safety and emergency activities needed during a severe storm event. The 1978 blizzard had severe impacts on vehicular access to damaged areas. Local roads, detailed in the next section, were rendered impassable.

Option 2

7.140 There would be little impact to public facilities and services due to the limited number of structures involved.

T. Transportation

Option 1

7.141 There would be an increase in flood-event transportation safety upon completion of Option 1 construction. Option 1 would reduce flooding of the MBTA Blue Line and Route 1A, as well as on local streets behind the LPP structures. Route 107 and the B&M Commuter Rail Line would still be subject to inundation.

7.142 The only negative impacts on transportation would be during construction. Because Option 1 entails four local protection plans, the impacts on transportation (specifically, traffic disruption) would be spread throughout the Study Area, including arteries and local roads. An average of about 70 truck trips per day would be generated by construction activities, for two years. Considering Route 1A in this region experiences about 30,500 vehicle trips per day, the trucking activity would pose only a minor impact to such an artery. The more significant impact to transportation created by Option 1 would be on local roads at the various construction sites.

Option 3

7.143 The completion of Option 3 construction would result in a significant increase in the availability of safe access and evacuation routes during a major storm event. Option 3 would reduce flooding of all major transportation arteries serving the Study Area and Boston's north shore and local streets inside the floodgates and behind shorefront structures.

7.144 The only negative impacts on transportation would be during construction. Impacts would be primarily restricted to the Revere Beach and Lynn Harbor areas and focused primarily on Route 1A in Revere and Lynn, and Ocean Avenue and Rice Avenue in Revere.

7.145 The construction of the non-floodgate features would require the greatest trucking component. There would be about 36 trucks per day for about a year during construction of these.

7.146 Over the three years of floodgate construction, the number of trucks would average about 12 per day. Some of the material would be delivered the final leg to the floodgate site via barges originating at the EDIC pier or Bay Marine, both located along the Lynn shorefront.

Option 2

7.147 Floodproofing of existing buildings would have a highly localized, site specific impact on traffic within the neighborhood of each individual project. There would be no long term impacts on transportation.

U. Navigation

Option 1

7.148 With Option 1 access would be provided for navigation interests to the waterfront and piers. Closures or gates would be constructed along the line of protection and would cause some inconveniences during construction.

Option 3

a. Construction Impacts

7.149 Construction of closures or gates to allow navigation interests to access the waterfront and piers through the coastal shorefront line of protection would cause some inconveniences during construction.

7.150 Construction of the floodgate structure would assure safe passage for navigation through a temporary channel around the work area. The construction plan includes a flow area not to exceed that of the N3 gate scheme, which is about 60% of the existing river flow area at mid tide. Currents during construction may exceed the three knot criteria (see definition under Long Term Impacts - paragraph 7-159) during tides approaching the maximum astronomic tide range. During design, model studies would evaluate currents during construction to assure safe navigation during construction.

7.150A Additional discussion of construction impacts, by alignment, follows.

Alignments 1 and 2:

7.151 A temporary navigation channel, as shown in the Plan Formulation Appendix, would be constructed during the Phase One construction of the navigation gate. The temporary channel would allow all vessels including the General Electric fuel barge or tanker to proceed up the channel and through the existing navigation opening under the General Edwards Bridge. No significant impact would occur for Alignment 1, or Alignment 2-the selected alignment.

Alignment 3:

7.152 Alignment 3 for the floodgates located about 150 feet east of the General Edwards Bridge would require construction across the opening of the navigation channel under the bridge. The General Edwards Bridge is a bascule bridge which normally raises its roadway at the navigation opening for barges and large sail boats. A temporary navigation channel would be dredged between the piers of the second span toward Lynn which has a clearance above MHW of about 20 feet and at MLW, 30 feet. There are about 30 sail boats which would not be able to pass under this span and would require mitigation measures during the approximate 1-1/2 year construction of the navigation gate. Also about 10 slips for vessels at the Point of Pines Yacht Club would be rendered useless during construction of the flushing gates on the Revere side. The General Electric Co. would need to truck their jet fuel to their complex for

unloading at their fuel unloading facility, since their fuel barge or tanker each month would not be able to pass under the bridge. A planned marina at the Lynn side of the alignment could be impacted.

Alignment 4:

7.153 Alignment 4, west of the General Edwards Bridge, would also close down the existing navigation opening requiring a temporary navigation channel similar to Alignment 3. General Electric would need to truck their fuel, and mitigation measures would be needed for the 30 large sail boats as well as for about 10 vessels whose slips would be rendered useless at Fowler's Marina during construction of the flushing gates on the Revere side.

7.154 Alignment 4 would also cause delays to vessels waiting to pass between the narrow opening between the navigation gate cofferdam and the General Electric pier with its salt water intake pump and pipeline. It is assumed that about 20% of the time a 10 minute delay would be encountered by the 350 vessels in the Saugus and Pines Rivers, while the navigation gate is being built, especially during the spring, summer and fall recreation boating seasons.

Alignment 5:

7.155 This alignment would not close off the existing navigation opening but would likely cause about a 5 minute delay 10% of the time due to a partial restriction in the navigation channel. The temporary navigation channel would also be too sharp a turn to allow the General Electric barge or tanker through, thus requiring trucking of their fuel. Use of a planned marina at the Revere side of the alignment would be significantly impacted.

b. Long Term Impacts

7.156 The openings in the floodgates are being designed so there would be no significant long term navigation effects after construction. The navigation gate would provide the same clear opening, 100 feet, as the existing 100 foot opening under the General Edwards Bridge, with unrestricted vertical clearance. All gates including the flushing gates would remain open almost 100 percent of the time except for the 2 to 3 times per year they would be closed during the threat of coastal storms. Generally closure would last about 1 to 2 hours during the peak of the flood tide. Vessel warnings would go out on Marine Radio from the US Coast Guard as well as at the flood gate well in advance of gate closure. The impacts to navigation, as experienced at similar projects, would be minor.

7.157 In the estuary, upstream of the gates, no significant change in currents is expected due to negligible changes in tides and flushing.

7.158 At the floodgates, with an open gated flow area nearly equal to the existing river flow area below mean sea level, there would be no significant change in current velocities.

7.159 The navigation current criteria of 'Not to Exceed a maximum velocity of about 3 knots (5.1 fps)' for this project would be met for the predicted maximum astronomic tide range with 0.8 feet (historical 100 year rate) of sea level rise. In order for vessels to navigate with or against a 3 knot current, they would need to be travelling at about 4.2 knots for adequate control. Navigation is posted at 5 miles per hour (or 4.3 knots) near the General Edwards Bridge. The currents at the gates should not pose a problem to navigation since the reported capability of lobster boats is 8 to 10 knots and sail boats is 5 to 6 knots. The fuel barge and tanker which service General Electric have a capability of 9 knots. The fuel dispatcher reported that a 3 knot current during mid-tide would not be a problem through the 100 foot navigation gate. Currently, the barge and tanker enter the river at high tide and depart a half hour before the following high tide due to river depth restrictions. (Currents for all tides approach 0 knots at high tide.)

7.160 The public is to be assured that the project will be designed for safe navigation. Detailed model studies and other efforts during the design stage will review navigation needs, eddys and currents in detail.

7.161 There would be a significant benefit to vessels moored in the Saugus and Pines Rivers as well as other vessels in need of a safe port during coastal storms and hurricanes. The protected rivers would serve as a Port of Refuge, providing safe mooring.

7.161A As indicated under 'construction impacts', access for navigation interests to the waterfront and piers would be provided through closures or gates constructed along the coastal shorefront line of protection.

7.161B Finally, it should be noted that the nonselected alternative floodgate Alignments 3 and 5 would physically impact planned marinas along the north and south shores of the Saugus River, respectively.

Option 2

7.162 No navigation impacts would occur with Option 2.

V. Recreation and Open Space

Option 1

7.163 Option 1, with its many miles of structures would impact access to the marsh and rivers. The dikes and walls would be about 5 to 6 feet high with vertical or stone surfaces preventing free access to the marsh or waterfront, except where gated openings are provided. The Revere Beach Dike Parkland would be enhanced for recreation, as described under Option 3, below. During construction of Option 1 there would be public access restrictions to construction sites... a minor impact.

Option 3

7.164 Recreation and open space opportunities would be only mildly impacted. Since the primary construction activities of the project would be along the

ocean shorefront, the interior area of the marsh and rivers would not be modified. Access to the marsh, now limited mostly to marine service businesses along the rivers, would not change. Knowing flood damage potential was reduced, communities surrounding the marsh may be encouraged to put into effect additional recreational plans. Several communities have, through their master plans, indicated a recommendation to change the zoning of the marsh and its surroundings from industrial to open space/ conservation. Recreational boating would not be impacted, as traditional access points would not be modified. The floodgate would not significantly change tidal velocities near the structure. It should be noted that the navigation opening will be 100 feet, the same as the General Edwards Bridge is now, and safe flows would be provided.

7.165 During construction of Option 3 there would be public access restrictions to construction sites... a minor impact.

7.166 The Revere Beach area would be the greatest benefactor in terms of recreational enhancement to the development of the Dike Parkland. It would be located over the flood protection embankment to be constructed between Revere Beach Boulevard and Ocean Avenue, from Beach Street to Revere Street. The park would serve passive uses encompassing walkways, lawns, benches, gardens, play equipment and other similar amenities. As explained in the Main Report, many of these features would be constructed separately by the Metropolitan District Commission following completion of the dike for this project. Also dune replacement and beach nourishment at Point of Pines would upgrade that area.

Option 2

7.167 There would be no significant impact to recreation and open space with the floodproofing of existing buildings.

W. Noise

Option 1

7.168 Noise from construction will be due primarily to trucking and heavy equipment operation in building the dikes and walls. Option 1 differs from Option 3 in the extensive impact area of the construction. Noise will impact more neighborhood areas in order to complete over eight miles of construction. The most obtrusive noise would likely be associated with the driving of piles.

Option 3

a. Construction Impacts

7.169 As with Option 1, trucking and construction activity would cause noise interference with the ambient environment. The most obtrusive noise would likely be associated with the driving of piles.

7.170 The preferred location for the floodgate is at the mouth of the Saugus River. The nearest residential section is located in Point of Pines, adjacent

to the floodgate. Most of the noise heard at Point of Pines would be similar to that from the compressor and work currently ongoing at the General Edwards Bridge. The floodgate itself would require, on average, only about five truck trips a day, so trucking noise impacts associated with this feature would be minimal.

7.171 Insofar as the construction of structures along Lynn Harbor is concerned, construction would be entirely along the shoreline at some distance from sensitive noise receptors. No residential areas are close by. Trucking impacts would mostly be felt in non-residential areas, including along Route 1A in Lynn.

7.172 The Revere Beach area is residential and would be impacted by the construction and trucking activities generated in the dike building. The same is true of the Point of Pines shorefront improvement.

b. Long Term Impacts

7.173 After completion, Option 3 would have minimal noise implications. The operations of the floodgate would occur initially on an average of 2 to 3 times per year, however the noise would be very short-lived (about 20 minutes to open and 20 minutes to close the gates) and not obtrusive. The movement of the water through the gates when open, which is most of the time, would be in the low decibel range similar to water passing under the General Edwards Bridge. General repairs over the life of the gate would entail some noise impacts of a temporary nature to the nearby areas of Point of Pines.

Option 2

7.174 Noise associated with floodproofing of structures would be similar to that associated with building construction. Impacts would be localized and vary considerably from site to site depending on the requirements for floodproofing.

X. Air Quality

Option 1 and Option 3

a. Construction Impacts

7.175 Typically, the most significant air quality impact from construction activities of this type is from dust raised by heavy equipment and trucking. The impacts associated with dust are respiratory irritation and degradation of sensitive mechanisms, as well as a dusty appearance of surfaces. There are several automobile sales operations that would be downwind at times of the Options 1 and 3 Lynn Harbor structures. Automobiles are stored outside and dealers would be likely to raise a concern. However, this specific impact would be expected to be minor and of short duration as construction progresses along the shoreline. Some of the Option 1 and all of the Option 3 construction area is adjacent to the seashore. Dust would be transported offshore

from these areas when winds are blowing in that direction. Primary use of barges for material hauling to the floodgate site in Option 3 would alleviate trucking dust impacts for that aspect of the project.

7.176 Emission impacts for construction activities on the project are the result of internal combustion engines. Generally, the impact from emissions is predicted to be negligible in light of present ambient standards.

7.177 Some of the Option 1 and all of the Option 3 construction area is adjacent to the seashore. Emissions would be transported offshore from these areas when winds are blowing in that direction.

b. Long Term Impacts

7.178 No impacts would be associated with Option 1. In Option 3, the operation of the floodgates would be powered by electricity with backup emergency generators. Because these gates would be operated so infrequently, there would be almost no impact to air quality during even rarer emergency generator use. General repairs to the floodgates could cause temporary and minor air quality impacts.

Option 2

7.179 Only very minor and localized construction-related impacts would be associated with Option 2.

Y. Visual Resources

General Visual Impact Assessment Procedure

7.180 The visual impact of each project structure can be measured in two primary aspects. First, the structure has a particular character or set of characters defined in terms of size, form, texture and materials. Visual impact can be measured by how this character fits into the local landscape character as defined by local land forms, vegetation patterns, urban development patterns and architectural styles. Concrete dams and rock covered embankments can be a significant visual intrusion because their massive form, regular shape, smooth texture and material color usually stand in strong contrast with their more natural surroundings. However, this contrast is lessened when the structure is located in a highly urbanized area rather than a naturally vegetated landscape. Contrast may also be lessened by using local building materials and structural forms that reflect local architectural styles and provide visually interesting shapes, colors and textures. Structural mass and regularity may also be reduced through the judicious use of plantings either on the structure (with proper engineering safeguards) or immediately adjacent to the structure.

7.181 Earthen dikes and concrete walls can also have a significant visual impact as their linear form often stands in strong contrast to the natural topography. Earthen dikes are also austere in texture, since their embankments are covered with either stone riprap or grass and kept free of any woody vegetation. However, walls are usually smaller in size and can be made to

blend into the landscape more readily by planting of screening vegetation. Both dikes and walls may be incorporated into other types of development such as parkland or recreational facilities.

7.182 A second visual impact is the visual obstruction that project structures may cause. To measure this impact, significant view points (vistas) must be determined. These are vantage points from which the general public is readily able to view significant structures and/or landscapes. View points may be from a fixed position such as a bridge, a building window or a park bench. Views can change dramatically with a change in elevation at a given view point. View points may be linear, such as the view of a person seated in a car traveling along a roadway or from the eye level of a pedestrian walking along a shoreline.

7.183 Assessing the visual obstruction impact of any structure must consider that vistas are defined by relation of the top elevation of the proposed structure to the eye level of the viewer and the elevation of the area being viewed.

7.184 Not all visual impacts from project structures need be negative. Project features may include pleasing shapes, colors and new textures. Structures may be screened from view by new vegetation or fences. Projects may also incorporate features that increase public access to views or enhance visually positive passive recreation opportunities.

Selection of Viewpoints

7.185 An existing extensive network of urban roads provides numerous visual access points and corridors around and through the estuary and along the coastal shorefront.

7.186 The low topographic relief in the Study Area prohibits any overview of the entire area from any one point. The I-95 highway embankment fill and the landfill near the waste disposal plant create visual barriers across the marsh. Several commercial and industrial developments restrict public access to the marsh shoreline, the river front and, in Lynn, the coastal shorefront.

Impacts of Each Alternative

a. Option 1 (Local Protection Plans)

Visual Impacts of Project Structures

7.187 The construction of 8.8 miles of various project structures would result in a significant change in the physical character of the project area. Project structures would be primarily grass covered earthen dikes, and would be a highly noticeable change on the landscape. However, grass faced dikes, combined with a limited amount of tree and shrub planting, can be a visual improvement in a highly urbanized area and can provide public open space as now occurs with the MDC park between Ocean Avenue and Revere Beach Boulevard in the vicinity of Beach Street.

Visual Access Restrictions

7.188 The Park Dike near the southern end of Revere Beach would restrict or block views of Broad Sound from the street level along Ocean Avenue and from the first floor elevation of the condominium complexes on the west side of Ocean Avenue. This impact is not significant as the first floor of these buildings is a parking garage and an entrance lobby. The residential condominiums are above the second flood level, where the dike will not restrict views of the water. Continuing the present type of combined dike and park development northward from the existing MDC park at Beach Street would be a visual as well as recreational improvement over the present vacant land and would screen the view of the parked cars along Revere Beach Boulevard. Development of this parkland would be conducted in cooperation with the MDC and would be an important part of the implementation of their Master Plan for the Revere Beach Reservation.

7.189 1700 feet of seawall at the north end of Revere Beach would be raised two feet severely limiting ocean views from along Revere Beach Boulevard and bordering residences.

7.190 Along the Lynn Harbor shorefront, the construction of new stone-faced dikes, raised and new walls is not considered to be a visual restriction since this area is either developed commercial property, not open to the public or other non-public property, not currently developed.

7.191 The structures which would surround the Saugus and Pines Rivers Estuary would have the most measurable visual impacts of Option 1. Structures would significantly restrict views of the Saugus and Pines Rivers and the associated marshes for many residences along the line of protection.

b. Option 2 (Nonstructural Plans)

7.192 Raising residential buildings and other floodproofing measures would change the character of some neighborhoods, but past flooding has already encouraged some homeowners to raise or otherwise floodproof their homes. The visual impact of this option would not be significant.

c. Option 3 (Regional Saugus River Floodgate Plan)

Visual Impacts of Project Structures

7.193 The significant structural features of Option 3 would be: the tidal floodgate at the mouth of the Saugus River; new shorefront features along Lynn Harbor; a new flood wall, stone revetment, restored dunes and beach renourishment at Point of Pines; and the MDC Park Dike. The visual impacts of the structures along Lynn Harbor and the MDC Park Dike would be the same as described in Option 1. The tidal flood gate would be located at the mouth of the Saugus River (Alignment 2), spanning the entire river from the existing flood wall along Rice Avenue at Point of Pines to the Lynn Dike along the South Harbor development area in Lynn.

7.194 Locating the tidal floodgate structure across the Saugus River from the Point of Pines shoreline to the Lynn Bulkhead, approximately 700 feet east of the General Edwards Bridge, would place the structure in a highly visible location. Constructing the floodgate structure at this location would be a significant change from the present open river channel and sand beach shoreline. The top of the dike would be at about elevation 15, two to three feet above the present seawall along Rice Avenue and 6 to 7 feet above Rice Avenue. The top of the floodgate structure near the Lynn side or center of the channel would be between elevation 20 and 23, seven to eleven feet above the Rice Avenue seawall and 11 to 15 feet above Rice Avenue.

7.195 The floodgate structure will consist of four major components: a navigation (miter) gate, ten flushing (tainter) gates, a concrete wall linking the gate structure to the Revere shoreline, and a concrete wall linking the gate structure to the Lynn shoreline. The concrete structure housing the navigation gate and flushing gates will undergo detailed architectural design during advanced engineering and design. Possible design detailing could be the use of shapes and materials that reflect the character of the nearby General Edwards Bridge. A recent example of architectural detailing to make a floodgate structure compatible and even an enhancement to its setting is the Charles River Dam at the mouth of the Charles River in downtown Boston. The dam was faced with brick to match the dominant building material of the area. The outlet portals of the pumping station were reshaped as shallow arches reflecting the shape of nearby bridges on the Charles. The adjacent banks were landscaped with plants, walkways, parking and lighting for public use.

7.196 The approaches to the floodgate structure where concrete walls link the structure to the Lynn and Revere shorelines would be landscaped to soften the transition between the wall and the shoreline.

7.197 The Point of Pines shorefront features would not change the visual character of the area, with the exception of the new and raised walls along the Saugus River.

Visual Access Restrictions

7.198 The project structures along Lynn Harbor and the MDC Park Dike would restrict views of the open water of Broad Sound as described in the assessment of project impacts under Option 1.

7.199 The tidal floodgate structure at the mouth of the Saugus River would restrict views primarily along the Point of Pines shoreline, south of the structure. The major viewpoints west and north of the floodgate structure are the General Edwards Bridge and the MDC fishing pier. From the bridge the floodgate structure will be highly visible but the view of Broad Sound will not be significantly restricted due to the higher elevation of the bridge deck. Views of the Sound would be obstructed for the fishing pier. If the fishing pier is removed (a decision to be made during project design), views would depend on to where fishing access would be relocated. A parking area for visitors to view the floodgate structure would be built at the Lynn side of the structure.

7.200 At Point of Pines, the combination of the approximately 7 foot high (above Rice Avenue) new and raised walls along the Saugus River (about 2-3 feet higher than the existing wall) and the floodgate structure would restrict views of Broad Sound for 15-20 homes along the northern end of Point of Pines. The other shorefront protection to be built along Point of Pines would cause no change in visual access from the present.

Z. Historic and Archaeological Resources

Option 1 (Local Protection Plans)

7.201 The construction of the Local Protection Projects (LPPs) could have an impact on prehistoric or historic period resources which may be buried beneath the marsh vegetation. Any evidence of past human activity located within the right of way for the dikes and walls would be destroyed during construction. If any of the LPPs are to be built, an archaeological survey, designed to locate archaeological deposits that are buried beneath the current marsh vegetation, would need to be conducted.

7.202 At this time, only portions of the Revere Beach Backshore LPP and the East Saugus LPP appear to have any potential for containing buried dry-land surfaces. From observations made during field visits, it is estimated that about 2750 linear feet of the Revere Beach Backshore LPP, in the vicinity of Oak Island, may have some buried site potential. The total impact area for the structure in this reach is estimated to be about 3.2 acres. In East Saugus, about 7800 linear feet of LPP structures, for a total impact area of about 9.1 acres, would warrant closer inspection for possible buried sites.

Option 2 (Nonstructural Plans)

7.203 There would be no anticipated impacts to either historic or prehistoric resources from nonstructural plans.

Option 3 (Regional Saugus River Floodgate Plan)

7.204 The Regional Plan would have no impacts on historic or prehistoric resources. The selected alignment for the floodgate will tie into recently (i.e. twentieth century) filled land on the Lynn shore and into the end of a highly mobile barrier beach at Point of Pines. The Point of Pines structures and those along the Lynn shoreline would all be in locations that have been severely disturbed within the last century by filling or flood protection construction. The MDC Park Dike would also be built on already disturbed lands.

7.205 The General Edwards Bridge is a 1934 Art-Deco style bridge, with a pair of double leaf, rolling lift bascule, scherzer-type lifts with under-deck counterweights. The 1934 construction date is late for this type of bridge. The bridge is not considered eligible for the National Register of Historic Places (Bill Smith, MHC, 1988 - personal communication), so the floodgate will not have an aesthetic effect on a historic property.

AA. Secondary and Cumulative Impacts

7.206 The primary concern regarding impacts of this sort relates to the inducement of land development within the Study Area as a result of implementation of one of the three project options. No induced land development is anticipated in the Study Area. It has been concluded that the proposed project options would not change the controlling factors in the floodplain outside of the marsh, which appear to be land availability and the general economic climate, and would in no way change the regulatory protection of the marsh itself. Detailed background on and discussion of this question may be found in Sections 6N and 7N of this document. Other secondary and cumulative impacts are discussed as part of the various Effects Sections (7A-2), as they are more easily kept in focus that way.

8.0 Sea Level Rise

A. Historic Rise

8.01 The question of Sea Level Rise is discussed in considerably more detail in the Hydrology and Hydraulics Appendix.

8.02 The overall long term historic rate of sea level rise on the east coast has generally been 1 to 1.5 feet per century. This apparent change in sea level has been ascribed to a combination of increased water volume in the ocean from melting glaciers and subsidence of the land in some regions. At the Boston Harbor National Ocean Survey tide gage, the rise relative to the land has been estimated to be 0.008 ft/yr from 1922 through 1980.

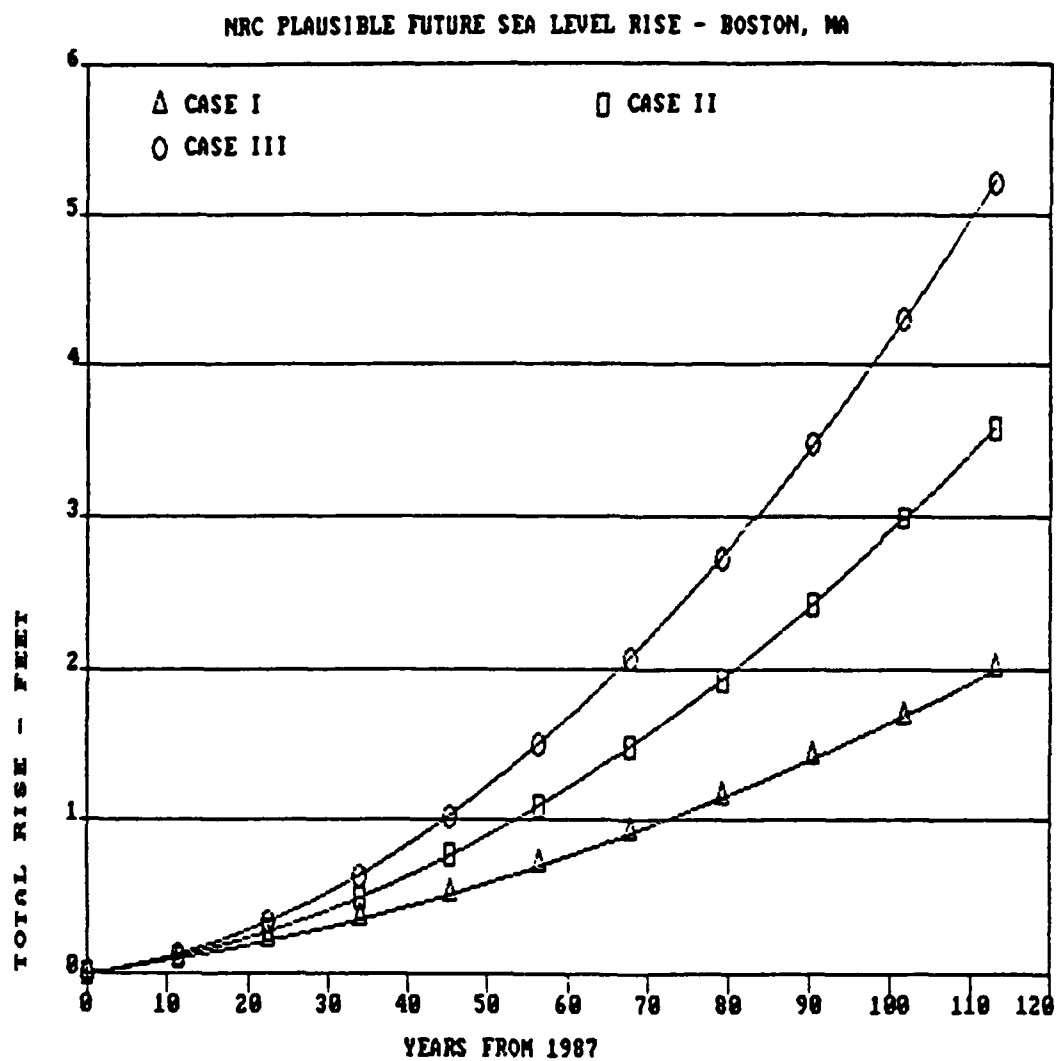
B. Future Sea Level Rise

8.03 In recent years there has been much discussion regarding a potential increased rate of future sea level rise. This phenomenon is related to a gradual warming of the earth's atmosphere associated with increased emissions of carbon dioxide and other gases on earth. The warmed atmosphere may promote expansion of near surface ocean water and increase the rate of melting of glaciers, thereby hastening the rate at which ocean levels appear to be rising. The scientific community appears in general agreement that the rate of global sea level rise will increase; however, there is lack of precision and agreement as to how much the increase will be. Several scientists have made projections employing mathematical models which simulate the processes involved. Based on these projections the increase in global sea level by 2075 could be as little as about 1 foot or as much as 7 feet. A middle estimate of 3 to 4 feet is accepted by many experts. This middle ground would yield an increase of nearly fourfold over historic rates in New England. The National Research Council (NRC, 1987) recently suggested that the sensitivity of design calculations and policy decisions be evaluated based on three plausible variations in sea level rise to the year 2100, all showing greater rate of rise in the distant future than in the next decade and all with an increased rate of rise relative to the present: 1.6, 3.3 and 4.9 feet. These estimates represent "Eustatic" or global changes. The local component which varies greatly from subsidence to uplift must also be included in estimating the total rise at a specific location. Figure 8.1 presents NRC total plausible rise at Boston for the three cases.

C. General Corps Policy Regarding Sea Level Rise

8.04 The Corps policy regarding sea level rise is one of concern rather than alarm. The Corps is trying to stay aware of ongoing developments to further define the complex issue, keeping in mind the inherent uncertainty in any projections.

8.05 Latest Corps 'draft' guidance on incorporation of Sea Level Rise into Feasibility Studies, dated June 20, 1988, recommends analyzing for the historical rate of rise and for the NRC curve III.



PLAUSIBLE SEA
LEVEL RISE
FROM NATIONAL
RESEARCH COUNCIL - 1987

Figure 8.1

8.06 For this Study Area the historic rate of rise has been 0.8 feet per 100 years and NRC curve III would yield an increase of 4.2 feet per 100 years. The sections to follow will present discussions keyed to these two rates of rise.

D. Effects of Rising Sea Level on Future Tidal Flood Frequency

8.07 Table 8.1 compares the frequency of tidal flooding in 2087 to that in 1987 assuming the historic 0.8 foot rate of rise and the 4.2 foot rate over the 100-year period. Even under historic rate conditions today's 100-year flood could become about a 25-year event. Considerable flooding and resulting economic losses would surely be associated with increasing ocean levels.

TABLE 8.1

FUTURE FREQUENCY OF TIDAL FLOODING
BOSTON, MASSACHUSETTS

Average Return <u>Period</u> (years)	1987 Stillwater <u>Elevation</u> (ft, NGVD)	2087 Projected Stillwater Elevation with <u>0.8 foot rise*</u> (ft, NGVD)	2087 Projected Stillwater Elevation with <u>4.2 foot rise*</u> (ft, NGVD)
10	9.1	9.9	13.3
50	10.0	10.8	14.2
100	10.3	11.1	14.5

* Does not include surge reduction due to increased depth, which is minor. See Hydrology and Hydraulics Appendix.

E. Effects of Future Sea Level Rise on Tidal Flood Plain Zones

8.08 A cursory assessment of the possible effects of future sea level rise on existing natural stage frequencies for the various floodplain zones has been made. Table 8.2 shows the future sea level condition Boston stillwater elevation frequencies in 100 years for an increase of 0.8 feet and 4.2 feet.

TABLE 8.2
FUTURE SEA LEVEL CONDITION BOSTON STILLWATER ELEVATION
FREQUENCIES IN 100 YEARS

<u>Percent Chance Occurrence Each Year</u>	<u>Existing Condition Elevation (ft, NGVD)</u>	<u>Future Condition (100-Years) Elevation with 0.8 foot rise* (ft, NGVD)</u>	<u>Future Condition (100-Years) Elevation with 4.2 foot rise* (ft, NGVD)</u>
0.05	12.0	12.8	16.2
0.2	11.2	12.0	15.4
1.0	10.3	11.1	14.5
10	9.1	9.9	13.3
50	8.3	9.1	12.5

* Does not include surge reduction due to increased depth, which is minor.
See Hydrology and Hydraulics Appendix.

F. Effect of Rising Sea Level On Tide Ranges and Currents

8.09 The increase in sea level in many sheltered embayments will be felt predominantly through an increased water level. The depth increase will facilitate the propagation of tidal waves due to depth dependence. Many areas which have sedimentation rates of the same order as the relative sea level rise will notice minimal change in tidal characteristics. Since sediment input to the Saugus and Pines Rivers Estuary is limited, it is felt that increased sea level will bring the estuarine tidal regime into closer phase with that on the open coast. Since most of the area, except the Sea Plane Basin, is now nearly in phase, these changes will generally be minimal.

8.10 The tidal prism may be substantially increased if significant sea level rise occurs since the Saugus/Pines Estuarine area which is now at about mean high water will routinely be flooded to much greater depth than at present. Also shoreline retreat could further increase the prism volume. The deeper water will also increase prism (volume of water) exchange by reduction of friction at the tidal entrance due to deeper water. O'Brien (1969) has shown a relationship between increase in tidal prism and increase in cross sectional area of a sandy tidal inlet, indicating they are directly proportional. Table 8.3, developed from the existing capacity curve for the Saugus and Pines Estuary, shows potential changes in mean tidal prism for the 0.8 and 4.2 foot cases of sea level rise. In actuality, erosion may significantly alter future tidal volumes. Tidal currents would be expected to increase similarly to the tidal prism.

TABLE 8.3

CHANGE IN TIDAL PRISM

<u>Scenario</u>	2087	Percent Change in Tidal Prism Using Existing Capacity, for Mean Tidal Range
	<u>Sea Level Rise (feet)</u>	
Projected Historic Rate	0.8	+9
NRC Case III	4.2	+100

8.11 This would indicate that under natural conditions the entrance to the Saugus River could begin a somewhat expansionist tendency which may at some point require evaluation of some measures to control erosion on the banks and channel scouring which may be causing problems at the existing bridge overpass.

G. Effects of Rising Sea Level on Waves

8.12 The combined effect of reduced wave dampening and augmented wave generation (see Hydrology and Hydraulics Appendix) would result in larger wave heights in the surf zone. Larger amounts of sediment would be moved and greater wave forces and potential for overtopping would exist. In the coastal areas this could mean accelerated beach/shorefront erosion along Revere Beach, Point of Pines and the Lynn shorefront. With excessive sea level rise, such as the 4.2 foot rate, and no continuing maintenance, breaching of barrier beaches cannot be ruled out as well as undermining and failure of existing seawalls and revetments. Minor sea level rise, on the order of the historic rate (0.8 feet), would at least create greater wave overtopping and flooding behind coastal structures. The amount of impact would increase as sea level rise increases. Major structural actions or abandonment might be necessary in the future in the Study Area and all along the United States Coast, if large accelerated sea level increase occurs.

H. Effects of Rising Sea Level on the Coastal Zone

8.13 Mean sea level is one of the primary factors determining shoreline position along sandy coastlines such as exist in the Study Area. It has been suggested by Swift et al. (1972) that a relationship exists between sediment supply, wave energy, sea level and shoreline position. Rising relative sea level will tend to promote shoreline recession, except when the influx of sediment can offset this recession. The present eroded state of Revere Beach is testimony to the argument that sediment influx is insufficient under present conditions to offset shoreline recession and that under future accelerated sea level rise things will just get worse. The link between shore retreat and sea level rise based on examination of beaches both developed and undeveloped, worldwide, indicates that the relationship is causal in nature (NRC, 1987). However, in some locations, man's activities relating to construction of seawalls, jetties, etc. have probably increased shoreline recession.

8.14 Bruun (1962) was the first individual to formulate a relationship between rising sea level and the rate of natural shoreline erosion. His basic premise is that each beach will try to maintain an "equilibrium profile," where material removed during shoreline retreat is transferred onto the adjacent inner shelf, thus maintaining the original beach profile and near-shore shallow water conditions. Of course, this concept is mainly applicable to natural beaches rather than those protected by seawalls as exist in the Study Area. However, for comparative purposes, examination of Bruun's concept is warranted. In general, Bruun's relationship shows that for a sea level rise S, the shoreline retreat will be about 100S. Table 8.4 presents possible shoreline retreat for the increases in sea level being considered in this Section.

TABLE 8.4

NATURAL BEACH RESPONSE TO
RISING SEA LEVEL

<u>Scenario</u>	2087 Sea Level <u>Increase</u> (feet)	Shoreline Retreat by Bruun <u>Relationship</u> (feet)
Projected Historic Rise	0.8	80
NRC Case III	4.2	420

8.15 It should be noted that areas like Revere Beach, Point of Pines and the Lynn shorefront will likely be subjected to greater erosional forces in the future as indicated by Bruun's relationship. Erosion will occur on beaches and at the base of seawalls and revetments, possibly causing undermining leading to failure, unless stringent maintenance practices are followed. Breaching of barrier beaches cannot be ruled out. Major structural actions to hold back the sea or abandonment may be required with major sea level rise. Breaching of the Nahant Causeway could seriously threaten Lynn Harbor which is now protected from deep ocean waves. The degree of shoreline erosion is closely related to the amount of sea level rise. Continued historical rate of rise will see a minor increase in erosion, whereas significantly accelerated rise (NRC Case III) could see substantial erosion. Significant expenditures would likely be necessary if the effects of a large increase in sea level were to be curbed.

8.16 Holding back the sea as water levels rise will almost always be technically feasible; however, in some cases it may not be economically or environmentally sound. Without political or emotional considerations, economics will be the final arbiter in deciding whether or not to retreat (NRC, 1987).

I. Effects of Rising Sea Level on Tidal Wetlands

8.17 Under each of the sea level rise scenarios of 0.8 and 4.2 feet/100 years the level of MLW and MHW will increase. Under "ideal" conditions the rise in sea level would be associated with a corresponding rise in the level of salt marsh.

8.18 The level of mean high water on-site closely correlates with the transition of low marsh, dominated by saltmarsh cordgrass, and high marsh, most often dominated by saltmeadow grass (Lefor et al., 1987). As MHW moves up in elevation the plant communities delineated by it also move up. The lower limit of the marsh is controlled by the tidal range, flooding frequency and the effects of waves (Mitsch and Gosselink, 1986). Lefor et al. (1987) found all salt marsh cordgrass plants in their study in Connecticut occurred between 0 and 50 cm below MHW on site. With a 0.8 foot rise in sea level MHW at the Saugus/Pines marsh would rise from about 5.0 feet to 5.8 feet. A 4.2 foot rise in sea level would result in a MHW level of 9.2 feet. If sedimentation cannot keep pace with these rises the amount of low marsh may decrease.

8.19 Salt marshes are able to adjust to sea level rise by expanding inland and waterward and increasing in elevation through accumulation of sediments and plant matter. Nixon (1982) in "The Ecology of New England High Salt Marshes: A Community Profile" summarizes the response of salt marshes to sea level rise. The most recent, and generally accepted, view of how marshes adjust to sea level was described by Redfield (1972) in his classic study of Barnstable Marsh on Cape Cod. His synthesis combined the earlier theories of N.S. Shales (1886) and B.F. Mudge (1862) on marsh development with new research and an understanding of the role of sea level rise. Nixon (1982) summarized Redfield's (1972) findings as follows: "With a rising sea level and a sufficient sediment supply...the intertidal *S. alterniflora* peat extended progressively out from shore and at an upward slope over an aggrading sand and mud deposit. The high marsh peat then formed over the intertidal peat as a wedge which thinned as it expanded toward the upland and the seaward edge of the marsh." This allows the marsh to grow outward along the seaward and upland edges and upward in elevation.

8.20 There are limits to the amount of expansion a given marsh may achieve. The major limiting factors are: 1) erosion at the seaward edge, 2) slope of the adjacent upland, and 3) sediment availability. These three limiting factors allow for three possible outcomes of sea level rise as identified by Orson et al. (1985): marsh drowning when sediment supply and accretion is less than the rate of coastal submergence (a combination of sea level rise and land subsidence); marsh expansion when sedimentation exceeds submergence; and marsh maintenance if sedimentation balances submergence.

8.21 Based on generalizations, assumptions can be made about the effect of sea level rise on the Saugus and Pines Rivers marsh. The effect of erosion on the seaward edge of the marsh is difficult to determine but would be dependent on the amount of sea level rise and the accretion rate. Bruun (1962, 1988) developed a method now known as the Bruun Rule to determine the erosion rate due to sea level rise. Summarily, this rule provides that a given rate of sea level rise will result in a quantity of eroded material from the shore and

material deposited in the nearshore zone equal to the height of sea level rise. The rule assumes the shoreline is in longshore equilibrium. Essentially, at the Saugus/Pines Marsh the nearshore zone would be the Saugus and Pines Rivers. The quantity of material eroded from the marsh edge would therefore have to be sufficient to cover the Saugus and Pines Rivers whose widths would expand with erosion, with 0.8 feet and 4.2 feet of material under each of the scenarios, minus sediment input from outside of the marsh.

8.22 A given erosion rate, which is not specifically known for the Study Area, but can be assumed to be quite high for the 4.2 foot scenario based on the preceding discussion, would require an increasingly greater accretion rate where the slope of the adjacent upland is greater, to maintain the marsh area (Phillips, 1986). Most of the uplands surrounding the Saugus/Pines marsh have a very high level of commercial and residential development and those areas that are not developed have relatively steep slopes. Owners of surrounding developed areas would assumably not allow the marsh to expand onto their properties. It is assumed that vertical or near vertical shoreline structures would be constructed to protect properties from flooding and consequently marsh expansion. These areas are therefore considered to have a very steep slope. Therefore, the entire marsh could only experience very limited landward expansion.

8.23 Expansion of salt marsh would most likely occur into those areas now dominated by shrub/forested swamp, Phragmites marsh, and fresh water-brackish marsh along the marsh/upland edge. This would simply be a response to the increase in sea level. No accretion would be necessary to maintain the marsh until the level of mean high water exceeded the level of these marshes. Approximately 50 acres of non salt marsh wetland would be available along the upland edge to transform to salt marsh.

8.24 Overall, because of the near vertical and very steep slopes of the surrounding uplands, the rate of accretion would have to equal that of sea level rise and subsidence to maintain the existing marsh with no erosion of the seaward edge.

8.25 Expansion or maintenance of the salt marsh along the seaward edge and the entire marsh surface is dependent on a sediment supply sufficient to keep pace with the rate of coastal submergence. A sea level rise of 0.8 feet (24.38 cm) over the next 100 years based on the historical rate of sea level rise would translate to 2.4 millimeters (0.008 feet) per year of sea level rise. The extreme rate of sea level rise being considered for this study of 4.2 feet (1.28 m) over 100 years would mean a yearly rate of 12.8 mm/year (0.042 ft). In order to maintain the marsh at the succeeding level each year, roughly 10 acre-feet ($12,500 \text{ m}^3$) for a 0.8 ft rise, or 55 acre-feet ($66,400 \text{ m}^3$) for a 4.2 foot rise, of sediment, per year would be required. The input of sediment to the Saugus and Pines Rivers Estuary is limited because the two inlet streams are very small and represent very little of the estuary's volume, and the input of sediments from Lynn Harbor and Broad Sound is minimal. This second point is evidenced by the fact that relatively minor amounts of sediment have accumulated in the Saugus River Channel since the last major dredging in 1952 (Bohlen, 1978). The removal of sediments for the Saugus or Pines navigation dredging projects could further reduce the

available sediment budget. It is expected that the elevation of the marsh surface would be able to keep pace with the 2.4 mm/yr sea level rise although it would likely be associated with erosion of the seaward edge of the marsh. Generally salt marshes have been able to keep pace with sea level rise of this magnitude (Nixon, 1982; Reed, 1988). If the input of sediments is insufficient, however, the seaward edge may erode providing sediment to the marsh surface (Reed, 1988). It is expected that this would occur at the Saugus/Pines marsh, but that the majority of the marsh would be able to maintain itself through sediment input.

8.26 Under the 4.2 foot or 12.8 mm/year sea level rise scenario major changes to the marsh would most likely occur. Nixon (1982) stated that "it is commonly thought that marsh development can only take place when the rate of sea level rise is slow," but he also reported that marsh development historically occurred over a 6,000 year period when the average rate of sea level rise was 16 mm/yr. He suggested two possible explanations for marshes having the ability to keep up with this rate of increase. Either marsh development can occur during periods of rapid sea level rise or marsh development occurred when sea level rise slowed during the 6,000 year period. He also reports that a study found that a young, actively growing marsh at Barnstable, Massachusetts increases at a rate exceeding 50 mm/yr. He theorized that "given an adequate sediment supply, the marsh grasses themselves are capable of dealing with rapid rates of sea level rise." Since the sediment supply to the Saugus/Pines marsh appears to be limited, it appears that the marsh would not be able to maintain itself at its present size with a 12.8 mm/yr rise in sea level. Erosion of the marsh face would likely occur resulting in a marsh area of some unknown size smaller than the present size and with an increased proportion of low marsh to high marsh.

J. Effects of Rising Sea Level on Water Quality

8.27 Any future rise in sea level would result in an increased frequency of wetland flooding and increased length of time during which the mudflats within the estuary would be under water. Increased shoreline erosion resulting in increased turbidity would take place until the estuary adjusts to the new tide level. Also, because there is substantially more volume available for storage at higher elevations, there would be an overall increase in flushing volume. The increased flushing volume would result in increased channel velocities and increased suspended solids loadings until the channel geometry has adjusted relative to the change in velocities. All the beneficial aspects of increased flushing on water quality would occur with rising sea level, including increased oxygen capacity of the tidal prism, increased nutrient exchange and increased dilution of pollutants.

K. Effects of Rising Sea Level with Flood Protection Measures

Option 1 - Four Local Protection Plans

8.28 Flood protection measures are generally built to provide protection up to some design flood event. For the LPPs this ranges from the SPN to the 100 year event. A 0.8 foot rise would somewhat reduce the protective capabilities of the Local Protection Plans. Areas with 100 year protection would begin to

experience problems with even a 0.8 foot rate of rise. A 4.2 foot rise would cause severe problems. Should sea level appear to be rising at such an increased rate additional studies would need to be conducted to determine if the height of the Option 1 structures should be increased.

8.29 The operation of any flood protection scheme will also be impacted by sea level rise. In the case of "separate local protection projects" the closure of flap gates and ponding of runoff behind the structures will become more frequent. Large increase in sea level might necessitate the addition of pumping stations to pump this runoff through the line of protection, increased sea level having minimized the effectiveness of gravitational discharges.

8.30 The effect of the LPPs on the marsh would change little with sea level rise. Since the area surrounding the marsh is already heavily developed the added barrier of the LPPs would not significantly limit the migration of the marsh inland over the without project condition, though some impact would likely occur.

Option 2 - Nonstructural Plans

8.31 Individually protected (floodproofed) structures would be more susceptible to flooding with sea level rise, with the increased risk depending on the type and degree of protection originally selected. Flood preparedness plans and evacuation would be implemented more often with rising sea levels.

Option 3 - Regional Saugus River Floodgate Plan

8.32 Nearly all of Option 3 is designed for the SPN event, except for Point of Pines and the Garfield School Area at the south end of Revere Beach, where 100 year protection would be provided. Also, damages at the north end of Revere Beach would be only partially reduced up to the SPN level.

8.33 A 0.8 foot rate of sea level rise would somewhat reduce the protective capabilities of the shorefront protective features of Option 3, except that Point of Pines and the Garfield School Area would begin to experience problems with even a 0.8 foot rate of rise. A 4.2 foot rate of rise could cause significant problems for all Option 3 shorefront protective features and would likely lead to studies into the potential for raising them.

8.34 The floodgate would also experience changed operation due to increases in sea level. As presently formulated the floodgates would be closed only a few times per year when storm tides are expected above about +8.0 feet, NGVD, this being the approximate start of flood damage. Normal tides, nearly all the time, would be allowed to pass virtually unobstructed through the open gates. However, with sea level rise, normal nonstorm high tides would increasingly cause flood damage throughout the area. This would necessitate more frequent closure of tidal floodgates during nonstorm periods. Three alternatives are considered for evaluating sea level rise:

Alternative 1 - assumes that there will be no change in the mode of operation of the gates; that is, the gates will close at seven feet when the

tide is expected to reach or exceed eight feet. Table 8.5 shows the approximate number and duration of closures that would be required under the 0.8 and 4.2 foot sea level rise scenarios.

TABLE 8.5

ALTERNATIVE 1 - FLOODGATE CLOSURES WITH SEA LEVEL RISE

<u>Sea Level Conditions</u>	<u>Average Annual Number Of High Tides > 7.5 (ft, NGVD)</u>	<u>Average Annual Number Of Floodgate Closures</u>	<u>Typical Period of Gate Closure (hours)</u>
Today	6	2-3	1-2
1.0 foot rise	80	35-45	2-3
4.2 foot rise	675	575-600	5-6

As can easily be seen, the total closure time would become very large for a 4.2 foot rate of sea level rise, resulting from both increased number and duration of closures.

8.35 Alternative 2 - assumes walls and dikes would be constructed about one foot high along portions of the upland border of the estuary for each foot of sea level rise. This would result in raising the start of damage and closure elevation of the floodgates by one foot per foot of rise. Each time 1.0 foot of sea level rise approaches the start of damage would be raised one foot and the number of closures reduced from about 35-45 back to 2-3 times per year.

Alternative 3 - assumes policy decisions, resulting from high accelerated rates of sea level rise, would dictate retreating from the coastal floodplain. As sea level rise reaches one foot about 35 years after project construction with case III, retreat of the floodplain could occur and the project would no longer need to function. As shown in the main report, the project is justified under this condition over a 35 year life.

8.36 Currents at the mouth of the Saugus River would increase with sea level rise with or without the floodgates. Since the floodgates would be designed for no significant change from existing currents, with sea level rise there would likely be no major difference in currents with the floodgates as opposed to without the floodgates. For Alternative 1 with a large sea level rise, the frequent and longer lasting gate closures that would be necessary (see Table 8.5) would significantly reduce the amount of water going into and out of the estuary and therefore hold down any increase in currents due to sea level rise. There would be no significant change with Alternative 2 and 3. See the Hydrology and Hydraulics Appendix for further details. Additional evaluation of currents with sea level rise will be made during project design.

8.36A The number and duration of closures would have an impact on navigation. For a 1.0 foot rate of sea level rise and alternatives 2 and 3, the frequency and duration of closures would not seriously impact navigational interests.

With Alternative 1 and a 4.2 foot rate of rise, the frequency and duration of closures would be prohibitive to navigation. In this case, a lock might need to be installed to allow vessels to bypass the floodgates when closed.

8.37 As far as wetlands are concerned, the operation of the floodgate would eliminate the highest tides with increasing frequency assuming sea level rise continues. According to Reed (1988) "Sediment can only be deposited during spring tides which flood the marsh, and during high water levels under storm conditions." As the gate is closed more and more frequently because of increases in the number of tides exceeding eight feet NGVD, more of the higher level and higher velocity tides which are capable of carrying sediment into the estuary will be eliminated. This could result in a decrease in the amount of sediment input to the marsh. The decreased sediment input would retard the ability of the marsh to keep pace with sea level rise resulting in greater replacement of marsh with open water. The magnitude of this impact is not known and would be dependent on the difference between the without project supply of sediment to the marsh and the with project supply. Alternative 1's impact would most likely be greater under the 4.2 foot sea level rise scenario. Alternatives 2 and 3 would likely have lesser impacts.

8.38 For all three alternatives and a one foot rise in sea level: Operation of the gate at the 7 foot tide level with the increasing number of tides reaching 8 feet will mean that the maximum level intertidal marsh can attain through accretion will be limited to the elevation flooded during an 8 foot tide. Given that the entire marsh is flooded during a 7 foot tide presently this will be used to generally approximate the highest level of marsh on the site. If the elevation of the marsh were increased by 1.0 foot to 8.0 feet under the historic sea level rise, salt marsh could still extend to that level (although it could be limited by decreased sediment input). A narrow fringe of the marsh would be flooded by 35-45 fewer tides per year. This could result in a change in plant species composition, toward less salt tolerant species, especially in the zone between the seven and eight foot tide levels. The marsh below the 7 foot elevation would be little changed from the without project condition. Encroachment of common reed along the fringes would most likely not occur because of the increase in the elevation of flooding and the steep side slopes.

8.39 If sea level were to rise by 4.2 feet the maximum level of salt marsh would have to increase to 11.2 feet to maintain the without project condition potential marsh elevation (marsh at this elevation is questionable under the without project condition because of limited sediment). With Alternative 1 the gates would be closed at 7 feet when the tides are expected to exceed 8 feet, however. This means that salt marsh could not exist above 8 feet in elevation. For this area (behind the gates) sea level rise would not exceed 8 feet but the level of MHW and the tidal regime would be affected by the gate operation. The level of the maximum tide within the gated area will be held to 8 feet while the level of MHW outside the gates will increase to roughly 9.2 feet. In addition, those tides between 7 and 8 feet will be affected by operation of the gates. With Alternatives 2 and 3 the marsh would have the opportunity to nearly achieve the without project condition.

8.40 Chronologically, both high marsh and low marsh will be present and little affected until MHW reaches 7 feet (from a two foot rise) with high marsh existing somewhere between MHW and the 8 foot flood elevation. Once MHW begins to exceed 7 feet the actual frequency of flooding associated with mean high water and Alternative 1 will be altered by operation of the gates. Actual MHW in the estuary can never exceed 7 feet with operation of the gates under Alternative 1, so only high marsh will be capable of growing between the elevations flooded by seven and eight foot tides. Once MHW exceeds 7 feet by more than 50 cm (1.6 feet) (this would occur when sea level rise reaches 3.6 feet), no low marsh will exist on the site (1.6 feet below MHW is a rough estimate of the lower limit of saltmarsh cordgrass growth). Alternatives 2 and 3 would only delay the attainment of the without project condition.

8.41 Regarding water quality with sea level rising, overall tidal flushing under the open gated condition would continue to increase. During gate closures of increasing duration and frequency some reduction in dispersion and mixing of pollutants and thermal discharges would be expected. As well, some salinity and dissolved oxygen reduction may occur. However, the greater mean tidal flushing when the gates are open would rapidly cause mixing, dispersion and removal of pollutants. Some easily settled pollutants may be somewhat retained. It is felt that water quality changes with Alternatives 2 and 3 resulting with 0.8 feet of sea level rise would be hard to notice. With Alternative 1, changes with two or more feet of rise would become increasingly more apparent and certainly be significant at 4.2 feet of rise with the substantial increase in the number and duration of closures. Changes would include greatly increased storage of pollutants and thermal discharges and reductions in salinity and dissolved oxygen.

L. Summary and Conclusion

8.44 The rate of sea level rise for the next 100 years has been considered, in accordance with Corps 'draft' guidance. Both the historical rate of 1.0 foot/100 years and the NRC Case III rate of 4.2 feet/100 years for the Study Area have been evaluated in a 'sensitivity analysis'. It is concluded that the 1.0 foot rate would have limited impact on the Study Area both without and with the project options. The 4.2 foot rate would have profound impacts, including serious considerations for structural/operational changes in project features. With Option 3 (Regional Floodgate Plan) implementing either alternatives 2 or 3 with sea level rise would have little impact on the estuary or navigation. Preliminary evaluations of Alternative 2 assuming today's conditions along the estuary shorefront, showed that the increased cost of walls and dikes would likely result in similar savings in reducing floodgate operating costs.

9.0 List of Preparers

The following people were primarily responsible for preparing this Environmental Impact Statement/Environmental Impact Report and the supplemental Environmental Appendix.

Ms. Kathleen A. Atwood

Discipline Expertise: Historical Archaeology

Education: MA - Historical Archaeology (expected 1989), University of Massachusetts, Boston

Experience: 2 years, archaeological studies, NED

Role in Preparing EIS/EIR: Historic Period Resources

Ms. Marie Lynn Bourassa

Discipline Expertise: Archaeology

Education: BA - Anthropology (1984), University of Massachusetts, Amherst

Experience: 3 years, NED Division Archaeologist; 2 years, Assistant to NED Division Archaeologist; 5 years' experience preparing cultural resource management studies for consulting firms.

Role in Preparing EIS/EIR: Prehistoric Period Resources and Historic Property Effects

Ms. Catherine Demos

Discipline Expertise: Biology/Coastal Ecology

Education: MS - Biology/Coastal Zone Mgmt. (1986), University of West Florida

Experience: 3 years, biological studies, NED

Role in Preparing EIS/EIR: Sandy Beaches, Artificial Shorelines

Mr. Joseph Finegan, P.E.

Discipline Expertise: Civil Engineering/Water Resources

Education: BS - Civil Engineering (1956), Tufts University

Experience: 17 years directing regulation activities at NED flood control reservoirs and hurricane barriers

Role in Preparing EIS/EIR: Adviser and Reviewer

Mr. Terrence S. Fleming

Discipline Expertise: Marine Ecology

Education: M.Sc. - Marine Ecology (1987), University of Massachusetts, Boston

Experience: 2 years, biological studies, NED

Role in Preparing EIS/EIR: Benthos

Mr. Charles B. Freeman

Discipline Expertise: Landscape Architecture/Aesthetics

Education: MLA (1974), Iowa State University

Experience: 14 years, recreation planning and project management, NED;
Massachusetts Registered Landscape Architect

Role in Preparing EIS/EIR: Visual Resources

Mr. Mark Geib, P.E.

Discipline Expertise: Hydraulic Engineering

Education: BSCE (1974), Pennsylvania State University

Experience: 14 years, water resources and flood control studies, Corps of
Engineers

Role in Preparing EIS/EIR: Riverine Hydrology

Dr. Joseph L. Horowitz

Discipline Expertise: General Ecology

Education: Ph.D - Biometeorology/Ecology (1975), Yale University

Experience: 12 years, EIS studies, NED

Role in Preparing EIS/EIR: DEIS/DEIR Manager

Mr. William A. Hubbard

Discipline Expertise: Marine Ecology

Education: BS - Marine Biology (1979), University of Rhode Island;

MS - Marine Biology (1983), Southern Connecticut State University

Experience: 4 years, marine ecology studies, NED; 5 years, marine
ecology research/consulting, Southern Connecticut State University

Role in Preparing EIS/EIR: Mitigation, author of responses to DEIS/DEIR
comments, FEIS/FEIR manager

Mr. Robert G. Hunt

Discipline Expertise: Civil Engineering

Education: Assoc. Degree - Business Administration (1979), Middlesex

Community College; BS - Agricultural Engineering (1969), University of Maine

Experience: 15 years, Project Manager of flood control studies, NED; 2 years,
design, Detroit District; 3 years, construction, Walla Walla District

Role in Preparing EIS/EIR: Project Manager

Ms. Judith L. Johnson

Discipline Expertise: Biology/Wildlife

Education: BS - Wildlife Biology (1978), University of Vermont

Experience: 4 years, biological studies, NED; 4 years, Soil Conservation
Service; 2 years, U.S. Forest Service

Role in Preparing EIS/EIR: Birds, Animals

Mr. Edmund J. O'Leary

Discipline Expertise: Economics

Education: MA - Economics (1972), University of New Hampshire

Experience: 6 years, economic studies, NED

Role in Preparing EIS/EIR: Socioeconomic Resources

Mr. Lawrence R. Oliver

Discipline Expertise: Biology/Wetlands

Education: BS - Natural Resources (1984), University of Rhode Island

Experience: 4 years, environmental studies, NED; 1 year, Rhode Island CZM; 1 year, wetland and wildlife research

Role in Preparing EIS/EIR: Wetlands, FEIS/FEIR manager, Ecological studies contract manager

Mr. J. Michael Penko

Discipline Expertise: Biology/Ecology

Education: MS - Ecology (1985), University of Minnesota

Experience: 2 years, biological studies, NED

Role in Preparing EIS/EIR: Plankton, Fisheries, Lobsters, Sedimentology

Mr. Paul Schimelfenyg, P.E.

Discipline Expertise: Geotechnical Engineering

Education: MS - Civil Engineering (1981), Rensselaer Poly. Inst.

Experience: 6 years, geotechnical studies, NED; 3 years, geotechnical consulting

Role in Preparing EIS/EIR: Geology, Topography, Soils, Seismicity

Mr. Donald Wood, P.E.

Discipline Expertise: Hydraulic Engineering

Education: BSCE (1972), Northeastern University

Experience: 9 years, hydraulic and water quality investigations, NED; 7 years, environmental consulting

Role in Preparing EIS/EIR: Tidal Hydrology, Water Quality

10.0 Public Involvement, Review and Consultation

A. Public Involvement Program

10.01 The New England Division (NED), Corps of Engineers has undertaken extensive public involvement and agency coordination throughout the progress of this study. Following is a review of the public involvement and coordination aspects of this study, which are also summarized in Table 10.1.

10.02 Earliest contact was developed and maintained between NED and officials of the communities requesting the study. As the study progressed contact was initiated with officials of pertinent Federal, State and local agencies, local interest groups, environmental organizations and others. All of these contacts were maintained throughout the course of the study, both through informal and formal discussions and meetings and through correspondence, and have had a profound impact on the directions taken by the study toward development of a technically feasible, economically justified, socially and environmentally acceptable, implementable plan.

10.03 During the period November, 1985 - January, 1986, NED held a series of five preliminary meetings with Federal, State and local agencies to introduce the study and solicit initial environmental concerns. In many cases, participants followed up on these meetings with written coordination, which was very helpful.

10.04 Subsequently, we held discussions with the Massachusetts Environmental Policy Act (MEPA) Office, and determined that a combined Federal and State (NEPA and MEPA) environmental review process would be of benefit to everyone. That is why we have prepared a combined Environmental Impact Statement/Environmental Impact Report (EIS/EIR). Figure 10.1 shows a schematic of this process, up to the Draft report stage. In June of 1986, to assist in this combined process, Massachusetts Secretary of Environmental Affairs James Hoyte assigned representatives from pertinent State Agencies to be contact points for us on this study. Mr. James O'Connell, of the Coastal Zone Management Office was named overall point-of-contact, to make sure coordination flowed smoothly.

10.05 Early in 1987 we held meetings in each of the four communities with Citizen Steering Committee candidates. The purpose of the Citizen Committees (one for each community) has been to insure that the Corps remain responsive to the needs and concerns of the communities as the study progresses.

10.06 At Citizen Committee meetings project updates have been presented and issues and concerns discussed. These committees have served as a focal point for dissemination of information to and receipt of feedback from the wider constituencies of the four communities. Membership in the committees has represented a crosscut of community official, commercial, residential, environmental and other interests. Rosters of the four Citizen Committees as they currently stand are presented in the Main Report.

Table 10.1
Saugus River and Tributaries. Flood Damage Reduction Study

Formal Coordination Activities

Nov. 1985-Jan. 1986: Five kick-off coordination meetings held with Federal, State and local officials.

Spring 1986: Corps decides to prepare combined EIS/EIR, after meeting with MEPA Office.

June 1986: Massachusetts Secretary of Environmental Affairs James Hoyte assigns contact points from State agencies.

Feb. 1987-Mar. 1987: Separate meetings to discuss the Environmental Notification Form (ENF) for the MEPA Process were held in Lynn, Malden, Revere and Saugus with Citizen Steering Committee Candidates who were provided the Project Information and Correspondence Binders.

March 1987: Technical Group formed, comprising representatives from Federal, State and local Agencies and environmental interest groups. The two Binders were provided to all members.

March 1987: ENF issued for the MEPA Process, signed by the four Communities as proponents.

April 1987: MEPA (EIR) Scoping Meeting held at Revere High School.

April 1987: Scope of effort for the EIR issued by Secretary Hoyte.

May 1987: NEPA (EIS) Scoping Meeting held at Saugus High School.

November 1987: Secretary Hoyte assigns MDC as joint proponent with the Communities for the Study.

November 1987: Field trip to Providence and New Bedford Hurricane Barriers for Technical Group and Citizen Steering Committee Members.

Jan. 1988-Feb. 1988: Citizen Steering Committee Meetings held in Lynn, Revere and Saugus.

February 1988: Technical Group Meeting held, in Boston.

June 1988: Point of Pines Public Workshops held in Revere to discuss impacts of floodgates.

October 1988: Two day Issue Resolution Conference held with Corps Headquarters, representatives of the Office of the Assistant Secretary of the Army and the Board of Engineers for Rivers and Harbors, and State and local sponsors, with a full day field trip to the Study Area.

December 1988: Meeting held with Federal and State agencies and local Conservation Commissions regarding enforcement of wetland protection regulations in the Study Area.

TABLE 10.1 (continued)

July 1989: Meetings were held with the Technical Group, Citizen Steering Committees and general public to discuss the draft report. A meeting was held in August with Point of Pines residents.

Nov 1989: A meeting was held with the project sponsors and state agencies to review state permit requirements and discuss project concerns and changes.

Flood Damage Reduction Study - Saugus River and Tributaries: Lynn, Malden, Revere, Saugus, MA

Joint MEPA/NEPA Process

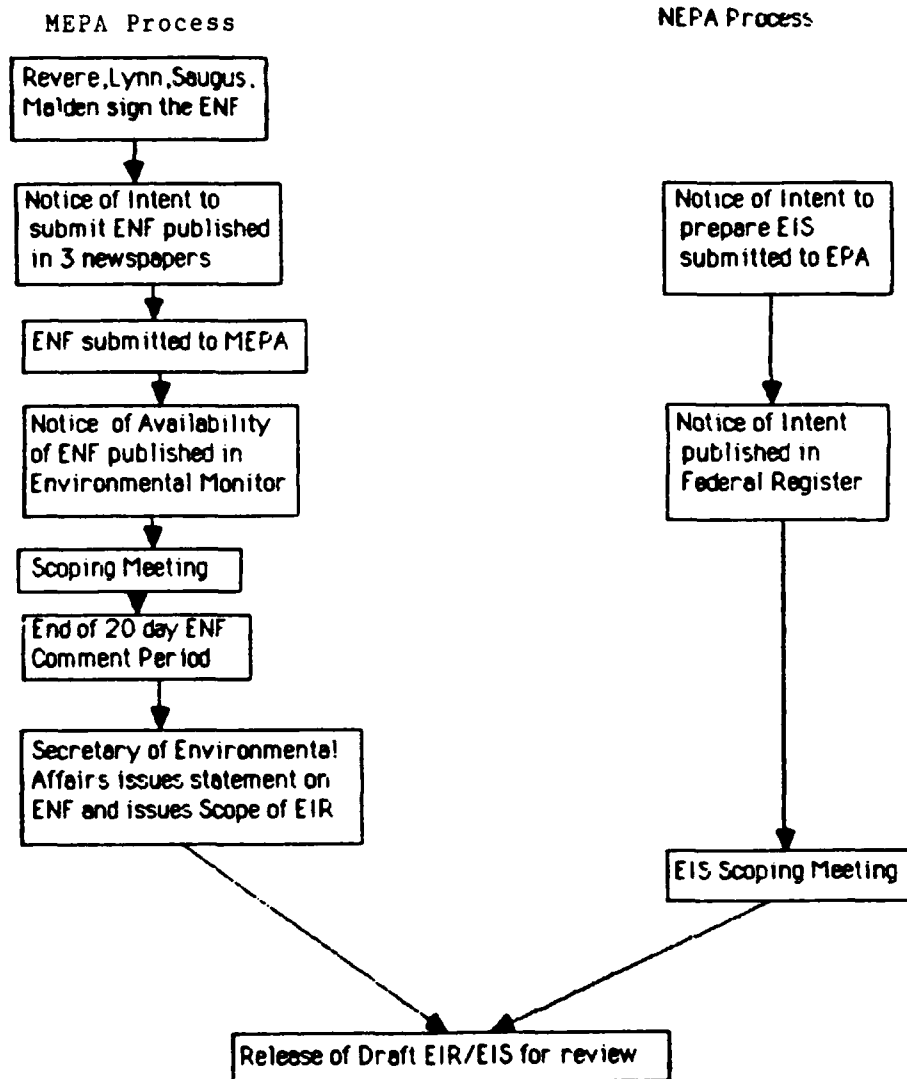


Figure 10.1

10.07 During the initial four Citizen Committee meetings we discussed the Environmental Notification Form (ENF) prepared by NED to help focus environmental questions of importance for the MEPA environmental review process. The ENF was then signed in each case by an appropriate official of the community as a co-proponent for the MEPA process. All committee candidates were provided two binders: a Project Information Binder describing the problems and options of the study and containing detailed information on project formulation and on the alternatives; and a Project Correspondence Binder containing copies of written correspondence with all interested entities concerning the study and dating back to the original requests by the communities. Both binders have been working documents and have been updated from time to time with new material, which has been sent to all members.

10.08 In March of 1987 we established a Technical Group to meet periodically with us, based on the original State Agency contact point assignments by Secretary Hoyte, plus additional members from Federal agencies, local agencies and environmental interest groups. The two binders were provided to all of the members. A roster of the Technical Group is presented in the Main Report.

10.09 In March of 1987, we formally issued the Environmental Notification Form for the MEPA process. In April, a MEPA Scoping Meeting was held at Revere High School. Several weeks later, we were issued a Scope of the effort required of the Environmental Impact Report (EIR), signed by Secretary Hoyte. In May of 1987, a Scoping Meeting was held at Saugus High School, to cover the Federal Environmental Impact Statement (EIS) requirements.

10.10 On November 9, 1987, Secretary Hoyte assigned his Metropolitan District Commission to serve as a joint proponent with the communities for this study.

10.11 On November 10, 1987, members of both the Technical Group and Citizen Steering Committees and the media were invited to attend a field trip to two existing hurricane barriers constructed by the Corps of Engineers. The purpose of this trip was to familiarize study participants with the type of project being considered under Option 3. A total of 54 people joined us, in two buses, on this all day tour to the Providence, RI Hurricane Barrier, operated and maintained by the city of Providence, and the New Bedford, MA Hurricane Barrier, operated and maintained by the Corps of Engineers. A worthwhile and enjoyable time was had by all.

10.12 In January and February, 1988 we held Citizen Steering Committee meetings in Revere, Saugus and Lynn. Study updates were provided and discussions took place on questions of concern and interest.

10.13 A Technical Group meeting was hosted by the Corps in Boston on February 25, 1988. Attendance was excellent and good dialogue was maintained. The primary purpose of the meeting was to present a study update and identify any red flags that needed to be addressed at this point in the study; and to see if our development of the study to this point, based to no small degree on previous coordination with the same interests, had missed any important considerations. It was emphasized that we wanted to continue to keep our focus on significant resources and concerns and to place the available monetary resources for the study in the areas of greatest importance. No significant

red flags or concerns surfaced at the meeting. After-meeting feedback from the participants was generally very positive, with comments ranging from "the meeting went very well" to describing it as "consensus building".

10.14 During the spring and summer of 1988, as Point of Pines was added to the study, a series of meetings and workshops was held by the Study Management Team in that area, with residents and other interests.

10.15 On October 18 and 19, 1988 NED hosted an Issue Resolution Conference on the study, including a full day field trip to the Study Area. The purpose of the meeting was to discuss the status of the study and its options with higher authorities in the Corps' chain of command, with involvement of the State and local sponsors. This was the first such meeting on any study at NED. It is a new concept, designed by Corps Headquarters to identify study problems early enough so that they can be resolved without significant impacts on the overall study schedule. All participants agreed that a very productive meeting took place.

10.16 On December 7, 1988, NED met with Federal and State agencies and local Conservation Commissions regarding needs, problems and opportunities pertinent to enforcement of wetland protection regulations in the Study Area. The subject of enforcement is critical to the estuarine storage protection feature of the preferred Option 3, the Regional Saugus River Floodgate Plan.

10.16A During the 90-day public review of the draft report, a Technical Group meeting and a Combined Citizen Steering Committee meeting were held to discuss the report and issues. Following the public review, meetings were held (e.g. November 28, 1989) with the sponsors and State agencies to discuss the State review and to request the State's view that the project will be consistent with their Coastal Zone Management Program and eligible for a Water Quality Certificate.

10.17 Throughout the course of this study, the general public was kept informed through press releases, contacts with media people (including invitations to important meetings) and presentations before neighborhood and other interest groups. The Study Manager and Environmental Manager were available by telephone to any interested parties.

B. Required Coordination

10.18 The extensive formal and informal agency and public coordination outlined above, in addition to the Corps' own technical judgment resulted in the determination of the areas of greatest emphasis for the overall study and for the EIS/EIR document. All of these same interests were afforded the opportunity to review the Draft Study Report and EIS/EIR. A 45-day review period took place during which comments were received by the Corps and by MEPA. All letters of comment appear in the Final Study Report and FEIS/FEIR, and all comments responded to in that document (see Appendix J). During the review period public workshops, Technical Group and Citizen Steering Committee meetings were held.

Table 10.2

Saugus River and Tributaries. Flood Damage Reduction StudyList of Recipients of Draft Study Report and EIS/EIRCongressionals

Congressman Markey	Washington, DC
Congressman Mavroules	Washington, DC
Senator Kennedy	Washington, DC
Senator Kerry	Washington, DC
State Legislators	Boston, MA

Agency or OrganizationOfficeLocationFederal Agencies

Advisory Council on Historic Pres.		Washington, DC
Department of H.U.D.	Regional Environmental Officer	Boston, MA
Department of the Interior	Office of Environmental Project Review	Washington, DC
EPA - Region 1	Asst. Director for Environmental Review	Boston, MA
Fed. Emergency Manage- ment Agency		Boston, MA
Fed. Highway Administra- tion - Region 1	District Engineer	Cambridge, MA
Fed. Railroad Administra- tion	Regional Director	Cambridge, MA
First Coast Guard District	Aids to Navigation	Boston, MA
Fish & Wildlife Svc. - Ecol. Services	Supervisor	Concord, NH
Geological Survey	District Chief	Boston, MA
NOAA		Washington, DC
NOAA - Fisheries	Chief, Habitat Conservation Branch	Gloucester, MA
National Park Service	Environmental Compliance	Boston, MA

State Agencies

Coastal Zone Management	Director	Boston, MA
DEM/Division of Water Resources	Director and Chief Engineer	Boston, MA
DEM/Division of Waterways	Director and Chief Engineer	Boston, MA

Dept. of Commerce and Dev.	Commissioner	Boston, MA
Dept. of Communities and Development	Assistant Secretary	Boston, MA
Dept. of Public Utilities		Boston, MA
DEQE/Div. of Wetlands & Waterways Reg.	Ch., Wetlands Section	Boston, MA
DEQE/Div. of Wetlands & Waterways Reg.	Ch., Waterways Reg. Section	Boston, MA
DEQE/Div. of Water Pollution Control	Director	Boston, MA
DFW&ELE/Nongame & Endangered Species	Director	Boston, MA
DFW&ELE/Div. of Fisheries and Wildlife	Director	Boston, MA
DFW&ELE/Div. of Marine Fisheries	Director	Boston, MA
Dept. of Public Works	Commissioner	Boston, MA
Energy Facilities Siting Council		Boston, MA
Executive Office of Environ. Affairs	Director, MEPA Unit	Boston, MA
Exec. Office of Commun. and Dev.	Senior Modernization Engineer	Boston, MA
Exec. Office of Economic Affairs	Secretary	Boston, MA
Exec. Office of Transp. and Constr.	Secretary	Boston, MA
Governor's Office of Econ. Dev.		Boston, MA
Mass. Bay Transp. Authority		Boston, MA
Mass. Historical Comm.	Executive Director	Boston, MA
Mass. Water Resources Authority		Boston, MA
Metropolitan District Comm.	Commissioner	Boston, MA
Metropolitan Area Planning Council		Boston, MA

Local

City of Lynn	Mayor	Lynn, MA
City of Lynn Conservation Comm.	Chairman	Lynn, MA
City of Malden	Mayor	Malden, MA
City of Malden Conservation Commission	Chairman	Malden, MA
City of Revere	Mayor	Revere, MA
City of Revere Conservation Commission	Chairman	Revere, MA
Town of Saugus Board of Selectmen	Chairman	Saugus, MA
Town of Saugus Conservation Commission	Chairman	Saugus, MA

Organizations & Others

Coastal Sportsmen Assoc.	President	Revere, MA
Conservation Law Foundation		Boston, MA
General Electric, Lynn	Manager	Lynn, MA
Utilities Opns.		
Italian Civic Association	President	Saugus, MA
Mass. Audubon Society		Gloucester, MA
Mass. Assoc. of Conserva-		
tion Comm.	President	Medford, MA
Mass. Wildlife Fed.	President	Carlisle, MA
Oak Island Residents Assoc.	President	Revere, MA
Pines River Association	President	Revere, MA
Point of Pines Beach	President	Revere, MA
Assoc.		
Point of Pines Yacht Club	Commodore	Revere, MA
Revere Beach Citizen	Chairperson	Revere, MA
Advisory Comm.		
Saugus Action Vol. for the		Saugus, MA
Environment		
Sierra Club	New England Chapter	Boston, MA
SWIM: Nahant Citizens	President	Nahant, MA
Committee		
Trout Unlimited	Chairman	Boston, MA

Citizen Steering Comm.		Lynn, Malden,
Members		Revere &
		Saugus, MA

Technical Group Members

Appendix J lists additional individuals receiving Draft and Final EIS/EIR.

C. Recipients of Draft Study Report and EIS/EIR

10.19 Table 10.2 is a list of recipients of the Draft Study Report and EIS/EIR, as well as the Final Study Report and FEIS/FEIR.

D. Public Views and Responses

10.20 Areas of greatest concern by agencies and the public and Corps responses to these follow.

10.21 The first area of concern is the desire that minimal or no losses of vegetated wetlands take place by virtue of project construction. Under the preferred Option 3, the Regional Plan, no vegetated wetlands would be lost. Option 2 would, by definition as nonstructural, cause no vegetated wetland losses. Under Option 1, 17.7 acres of vegetated wetlands would be lost.

10.22 The second area of concern is the desire that minimal or no impact on the dynamics of the estuarine ecosystem and navigational safety take place by virtue of construction and operation of Option 3's floodgate structure at the mouth of the Saugus River. The floodgate structure and its proposed operational mode have been specifically designed for no significant adverse impact on the dynamics of the estuary and navigational safety. This is supported by the environmental analyses contained within this document.

10.23 The third area of concern is that the construction of flood protective structures would cause induced land development pressures within the estuary. This concern led to an extensive independent study of the question by IEP, Incorporated of Northborough, Massachusetts, under contract to the Corps. IEP studied such factors, both with and without the proposed project options, as historical and existing land use (including wetland filling), developable land available, plans for development, pressures for development and barriers to development (including economic, regulatory, topographic and other factors). IEP concluded that without the proposed project, development will continue within the floodplain as long as it is economical and the land is available. Development within the marsh is precluded by regulation, although illegal filling continues to some degree. The proposed project options would not change the controlling factors outside of the marsh, which appear to be land availability and the general economic climate, and would not change the regulatory protection of the marsh itself. Therefore, it was concluded that the protection afforded against flooding by the project options would not lead to any induced development within the marsh or the floodplain. In fact, acquisition of the estuary storage area, increased monitoring and enforcement of existing regulations, including education of all pertinent interests, would be required of the project sponsors, with support of the Federal agencies, to assure protection of the natural estuarine flood storage area under Option 3, the Regional Plan.

10.24 Finally, along the Lynn Harbor shorefront, dikes were moved inland which was found to be the most cost effective solution. This in turn avoided 5.6 acres of impact on intertidal habitat.

10.25 Several agencies believed a total non-structural plan should be developed and selected. A total non-structural plan to include non-structural improvements to all buildings in the floodplain was evaluated. The results found that the plan was not economically feasible nor could public safety be assured, and therefore not selected.

10.26. In general, comments from all DEIS/DEIR reviewers focused on concern for estuary protection, increased discussion of the non-structural alternatives, practical avoidance of impacts to Lynn Harbor intertidal habitat and a definitive design criteria for Sea Level Rise. Section 2 of the FEIS/FEIR and the Main Report briefly summarizes the responses to these issues. Appendix J provides detailed comment and responses to all reviewers replies.

11.0 Relationship to Environmental Protection Statutes and other Environmental Requirements

A. Compliance with Environmental Federal Statutes and Executive Orders

Federal Statutes

(1) Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972, as amended) 33 U.S.C. 1251 et seq.

Compliance: A Section 404(b)(1) Evaluation has been incorporated into this report. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.

(2) Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1401 et seq.

Compliance: The disposal of approximately 114,200 cubic yards of dredged material would be at the Massachusetts Bay Disposal Site. The material will be reviewed by the Corps under the provisions of this Act, including appropriate testing, during the project design phase.

(3) National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: The project was coordinated with the State Historic Preservation Office to determine whether historic or archaeological resources would be affected by the proposed project.

(4) Preservation of Historic and Archaeological Data Act of 1974, as amended, 16 U.S.C. 469 et seq. This amends the Reservoir Salvage Act of 1960 (16 U.S.C. 469).

Compliance: If any significant historic properties are identified within the project impact area, impacts will be avoided, minimized or mitigated. Treatment of properties will be described in a MOA between NED, Corps of Engineers, the State Historic Preservation Office and the Advisory Council on Historic Preservation.

(5) Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: Coordination with the U.S. Fish and Wildlife Service (FWS) and NOAA-Fisheries has yielded no formal consultation requirements pursuant to Section 7 of the Endangered Species Act.

(6) Estuary Protection Act, 16 U.S.C. 1221

Compliance: Review of the Study Report and EIS by the Department of the Interior signifies compliance.

(7) Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: Coordination with the FWS, NOAA-Fisheries and the appropriate State fish and wildlife agencies during the development and through the circulation of this document signifies compliance with the Fish and Wildlife Coordination Act. The Division Engineer has given full consideration to fish and wildlife conservation in evaluating the project.

(8) National Environmental Policy Act (NEPA) of 1969, as amended, 42 U.S.C. 4321 et seq.

Compliance: Preparation of this Draft Environmental Impact Statement (EIS) signifies partial compliance with NEPA. Full compliance shall be noted at the time the Final EIS and Record of Decision are released.

(9) Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 et seq.

Compliance: Not applicable; the project is not located in a river listed (section 2) or proposed for inclusion (section 3) in the Act.

(10) Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1431 et seq.

Compliance: A CZM Consistency Determination shall be provided to the State for review and concurrence that the proposed project is consistent to the maximum extent practicable with the approved State CZM program.

(11) Clean Air Act, as amended, U.S.C. 7401 et seq.

Compliance: The availability of this report to the Regional Administrator of the Environmental Protection Agency for review pursuant to Sections 176c and 309 of the Clean Air Act signifies compliance.

(12) Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: The Division Engineer has given full consideration to opportunities afforded by the Project for outdoor recreation and fish and wildlife enhancement. Review of the Study Report and EIS by the Department of the Interior signifies compliance.

(13) Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-1.

Compliance: Furnishing of this report to the National Park Service (NPS) and the Massachusetts Governor's Office of Economic Development relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

(14) Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

Compliance: No requirements for Corps' projects or programs authorized by Congress.

(15) Watershed Protection and Flood Prevention Act, as amended, 16 U.S.C. 1001 et seq.

Compliance: No requirements for Corps' activities.

Executive Orders

(1) Executive Order 11988, Floodplain Management, May 24, 1977, amended by Executive Order 12148, July 20, 1979.

Compliance: None of the three project options directly or indirectly supports floodplain development. Circulation of this report for public review fulfills the requirements of Executive Order 11988.

(2) Executive Order 11990, Protection of Wetlands, May 24, 1977.

Compliance: No induced development in wetlands would be promoted by any of the project options. Maintenance of the natural estuarine system would continue under all of the project options. The preferred Option 3 would destroy no vegetated wetlands (Option 1 would destroy 17.7 acres of vegetated wetlands). The necessary loss of intertidal (2 acres) and subtidal (1 acre) habitat for the Option 3 structures would be mitigated. In fact, the need for preservation of estuarine ponding area as a project feature would require protection of 5400 acre-feet of estuarine flood storage area through acquisition of this estuary flood storage area and improved monitoring and enforcement of existing regulations where enforcement presently is not entirely effective. Option 3 impacts are considered to be consistent with the Executive Order's intent to minimize the destruction, loss and degradation of wetlands. Circulation of this report for public review fulfills the requirements of Executive Order 11990.

'The Five Points of NEPA'

The National Environmental Policy Act (NEPA) requires (NEPA 102 (C)(i)-(v)) that all agencies of the Federal Government shall--

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on--

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Items i, ii, and iii, above, are dealt with in detail in Sections 5-7 of this document. Following are statements for the remaining two 'Points of NEPA.'

(iv) Relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity

Provision of flood protection is important for the long-term viability and vitality of this important residential, commercial and industrial area and transportation corridor. The short-term adverse effects described in this EIS/EIR are necessary to the work that will allow the long-term benefits to be realized. The preferred Option 3 has been designed for no significant long-term adverse impacts on the environment, including no significant adverse impacts on the dynamics of the Saugus/Pines Rivers Estuary, and thus has been designed to promote the maintenance of long-term productivity from an environmental perspective.

(v) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

The only irreversible and irretrievable commitments of resources would be the permanent loss of 9.4 acres of intertidal habitat and 0.6 acres of subtidal habitat, all of which would be mitigated, and permanent visual access restrictions for 15-20 homes at Point of Pines.

B. Compliance with State Laws and Policies

Massachusetts Environmental Policy Act (MEPA)

MEPA provides a uniform method of gathering information to be used in evaluating the impact of an activity. MEPA also provides for public and State agency review and comment on activities which either require a State permit, are conducted by State agencies, or use State funds. Projects which are within the jurisdiction of MEPA require the filing of an Environmental Notification Form (ENF). Where an Environmental Impact Report (EIR) is deemed required, the Secretary of Environmental Affairs issues a Certificate and Scope of the effort required of the EIR. The ENF for this study was released by the Corps in March of 1987, on behalf of the study proponents. The Scope of the effort for the EIR was issued by Secretary Hoyte on April 27, 1987, and is attached. MEPA and the Corps have agreed that a combined EIS/EIR would be beneficial. Appropriate public and agency review of the combined Draft EIS/EIR and issuance and review and approval of a Final EIS/EIR signifies compliance with MEPA.



The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202

MICHAEL S. DUKAKIS
GOVERNOR

JAMES S. HOYTE
SECRETARY

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME : Flood Damage Reduction Study
PROJECT LOCATION : Lynn, Malden, Revere and Saugus
EOEA NUMBER : 6497
PROJECT PROPONENT : U.S. Army, Corps of Engineers
DATE NOTICED IN MONITOR : March 26, 1987

Pursuant to the Massachusetts Environmental Policy Act (G.L., c.30, s.61-62H) and Sections 11.04 and 11.06 of the MEPA regulations (301 CMR 11.00), I hereby determine that the above project requires the preparation of an Environmental Impact Report.

The proposed project in some of its alternatives is categorically included among those projects for which an Environmental Impact Report is required. The Corps of Engineers have also concluded that a Federal Environmental Impact Statement is required. My goal is that a single document be adequate to satisfy both the State and Federal environmental review. For that reason it is provided that the enclosed Scope may be expanded to include the Federal needs such as economic and social impacts. The state review will consider the entire document.

The project is complicated by several other state/federal actions in the area. Most important to this project are the removal of the I/95 embankment for Revere Beach Renourishment and Mass. DPW highway projects and the local/state/federal enlarged navigational channel in the Saugus River. Both projects are now

planned, but not existing, so that background data with the projects are not available. However, both are projected to be in place prior to construction of the Flood Damage Reduction Project. Thus, the analysis and modeling efforts are complicated by the need to separate impacts from these earlier projects from the impacts of the current proposal.

In basic form the EIR needs to evaluate potential changes in tidal flushing, storm surges, sediment transport, and water quality in order to assess the impacts of any potential changes on operations, processes, and resources in the area. In addition, the revised FEMA flood elevations are necessary to allow local, state, federal landuse regulatory changes and to evaluate potential land use changes following the project.

On the state level, a strong mitigation plan is necessary for identified potential significant impacts and since a M.G.L. ch.130,s.40 waiver would be required for some options, an analysis of the ability to meet the waiver criteria is needed. Also, since some state agency will become a proponent for a percentage of the project, the final EIR should contain a draft M.G.L. ch.30,s.61 finding.

S C O P E

i. Evaluation of changes in the physical environment from today, through other proposed changes to implementation of the current proposals. Such analysis must included:

A. Tidal Flushing

- 1) Mean
- 2) Spring
- 3) Storm

B. Sediment Transport

- 1) within the estuary
- 2) from the estuary

C. Water Quality consider for both normal and storm conditions

- 1) salinity
 - a. boundaries
 - b. quality changes
- 2) contaminants such as mercury and hydrocarbons

- D. Storm Surge - changes both within and outside the flood control structures must be evaluated.
 - E. Flood Stage/Frequency - changes in flood levels as used by FEMA should be presented. Identify if structures are in the new flood zones.
- II. Environmental impacts of both construction and operation of the alternative strategies on the following issues must be evaluated.
- A. Water Quality - construction impacts of dredging, etc. need analysis.
 - B. Wetland Resources - Each of the wetland resource areas under M.G.L. ch.131,s.40, including wildlife habitat must be separately quantified and evaluated.
 - C. Fisheries - Catadromous, Anadromous, Flounder nursery, and Sea Run Brown Trout must be considered.
 - D. Water fowl - include nesting, feeding over-wintering and migratory use.
 - E. Benthic Community - include shellfish, sea worms, etc.
 - F. Aesthetics/Recreation - both physical and visual access to the estuary and recreation areas should be evaluated.
 - G. Navigational Impacts - include current changing and channel closing impacts.
 - H. Community Growth - suggested future growth should consider the changed flood status, but also that the enclosed basin of the hurricane dike would act as an inland wetland for mainland runoff when closed, which may preclude filling without compensation.
- III. Mitigation - Specific mitigation should be proposed, evaluated and adopted if feasible for each significant impact identified above.
- IV. Waiver - For each alternative requiring a waiver under M.G.L. ch.131,s.40, the ability to meet the waiver criteria must be fully evaluated.
- V. Section 61 Finding - A state agency will become a partner of the adopted flood reduction program. This agency and every other state agency acting on the proposal must include a section 61

EOZA #6497

ENF Certificate

April 27, 1987

finding in their action. The Final Impact Report must contain a draft section 61 finding for the entire project.

April 27, 1987

DATE



JAMES S. HOYTE SECRETARY

JSH/DES/bk

Massachusetts Wetlands Protection Act (WPA)-Massachusetts General Laws, Chapter 131, Section 40

The Wetlands Protection Act requires that no one shall remove, fill, dredge or alter any coastal or freshwater wetlands without a review by the local Conservation Commission(s) to protect specific interests as stated in the Act. The definition of wetlands provided by the Act includes such resource areas as coastal banks, dunes, beaches, saltmarshes, land under waterbodies and land subject to flooding. The Conservation Commission(s) must hold an open hearing(s) to determine whether the area or the impacts of the project are significant to the eight public interests specified by the Act. These are:

- 1) public or private water supply
- 2) ground water supply
- 3) flood control
- 4) storm damage protection
- 5) prevention of pollution
- 6) land containing shellfish
- 7) fisheries
- 8) wildlife habitat

The Conservation Commission(s) will then issue an Order(s) of Conditions regulating the project to protect those interests.

Under the regulations governing activities in coastal sites, performance standards are set for projects proposed for various resource areas. The standard for most work in a coastal bank; coastal beach; dune; land under a salt pond; land containing shellfish; wildlife habitat; and banks of, or land under, the ocean, rivers, streams, creeks, ponds or lakes that are part of an anadromous/catadromous fish run is "no adverse effect". The standard for a salt marsh is even more stringent, stating that a project "shall not destroy any portion of the salt marsh and shall not have an adverse effect on the productivity of the salt marsh". For most activities proposed on land under the ocean, tidal flats, coastal dunes (when an activity is accessory to existing building, excluding coastal engineering structures), and rocky intertidal shores, the standard is to "minimize" adverse effects on the eight interests of the Act.

Table 11.1 shows how the three study options would interact with the eleven coastal wetland resource areas of the Wetlands Protection Act.

The Wetlands Protection Act provides for a variance procedure at Paragraph 10.36 of the Regulations. This paragraph states that:

"The Commissioner may waive the application of any regulation(s) in Part II of 310 CMR 10.00 "(pertaining to the eleven coastal wetland resource areas)" when he finds, after opportunity for an adjudicatory hearing, that:

(1) there are no reasonable conditions or alternatives that would allow the project to proceed in compliance with the regulation(s);

TABLE 11.1
Saugus River and Tributaries Flood Damage Reduction Study
Massachusetts Wetlands Protection Act

	Option 1	Option 1	Option 2	Option 3	Option 3
	Five Local Protection Plans-Impacts	Comments and Ability to Meet Waiver Criteria	Nonstructural Plans-Impacts	Regional Saugus River Floodgate Plan-Impacts	Comments and Ability to Meet Waiver Criteria
Land Under the Ocean	No Impact	N.A.	No Impact	2.0 subtidal acres directly impacted, but net loss of 1.0 subtidal acres. 4.5 acres impacted during construction.	Full mitigation for loss will occur through construction of subtidal habitat at the I-95 Mitigation Site.
Designated Port Areas	N.A.	N.A.	N.A.	N.A.	N.A.
Coastal Beaches (includes tidal flats)	14.6 intertidal acres lost. 2.9 intertidal acres impacted during construction.	Full mitigation will occur through construction of intertidal habitat at the I-95 Mitigation Site.	No Impact	2.0 intertidal acres lost. 0.6 intertidal acres impacted during construction.	Full mitigation will occur through construction of intertidal habitat at the I-95 Mitigation Site.
Coastal Dunes	No Impact	N.A.	No Impact	1600 feet of existing coastal dunes at Point of Pines will be removed, then restored and replanted atop a new revetment.	No mitigation necessary.

	<u>Option 1</u>	<u>Option 1</u>	<u>Option 2</u>	<u>Option 3</u>	<u>Option 3</u>
	<u>Five Local Protec-</u> <u>tion Plans-Impacts</u>	<u>Comments and Ability</u> <u>to Meet Waiver</u> <u>Criteria</u>	<u>Nonstructural Plans</u> <u>-Impacts</u>	<u>Regional Saugus</u> <u>River Floodgate</u> <u>Plan-Impacts</u>	<u>Comments and Ability</u> <u>to Meet Waiver</u> <u>Criteria</u>
Barrier Beaches	No Impact	N.A.	No Impact	At Pt. of Pines: 0.1 acres of beach lost; 6 acres of new beach will be constructed through nourishment.	N.A.
Coastal Banks	No Impact	N.A.	No Impact	No Impact	N.A.
Rocky Intertidal Shores	Rocky intertidal habitat will be created along the Lynn Harbor shoreline.	N.A.	No Impact	Rocky intertidal habitat will be created along the Lynn Harbor shore- line and the floodgate struc- ture.	N.A.
Salt Marshes	17.7 acres lost. Temporary construction impact to up to 10 acres.	Full mitigation will occur for the lost acreage by construct- ing wetland habitat from the I-95 embank- ment.	No Impact	No Impact	N.A.
Land Under Salt Ponds	No Impact	N.A.	No Impact	No Impact	N.A.

	<u>Option 1</u>	<u>Option 2</u>	<u>Option 3</u>
	<u>Five Local Protection Plans-Impacts</u>	<u>Nonstructural Plans-Impacts</u>	<u>Regional Saugus River Floodgate Plan-Impacts</u>
			<u>Comments and Ability to Meet Waiver Criteria</u>
Land Containing Shellfish	14.6 intertidal acres lost. 2.9 intertidal acres impacted during construction.	No Impact	Full mitigation will occur through construction of intertidal habitat at the I-95 Mitigation Site, including shellfish transplanting.
Banks of or Land Under the Ocean that Underlie on Anadromous/Catadromous Fish Run	No Impact	No Impact	The design of the floodgate structure will keep floodgate impacts in the minor category. Compensation will be afforded by the wetland fringe constructed at the mitigation areas as well as by estuary acquisition, monitoring and protection of the estuarine flood storage area as a project feature.

(2) that mitigating measures are proposed that will allow the project to be conditioned so as to contribute to the protection of the interests identified in the Act; and

(3) that the variance is necessary to accommodate an overriding community, regional, State or national public interest; or that it is necessary to avoid an Order that so restricts the use of property as to constitute an unconstitutional taking without compensation."

The Scope of the effort for the EIR for this study stipulates that since a Wetlands Protection Act "waiver would be required for some options, an analysis of the ability to meet the waiver criteria is needed". The following addresses the three qualifying conditions for waiver that are in Paragraph 10.36 of the Regulations, for the two structural options.

Option 1 - Four Local Protection Plans

re: (1) See Option 3 discussion, below. Option 3 is the preferred option and is a reasonable alternative to Option 1.

re: (2) Impacts and mitigating measures are described, resource by resource, in Table 11.1.

re: (3) The public interest would be significantly served by the protection of 3950 structures against tidal flooding, and the reduction of flooding of the MBTA Blue Line and Route 1A, as well as on local streets behind the LPP structures. The National interest would be served by protection of the GE Plant in Lynn.

Option 3 - Regional Saugus River Floodgate Plan

re: (1) This, the preferred option, would destroy no vegetated wetlands, as opposed to 17.7 acres for Option 1. Combined loss of intertidal/subtidal habitat would be three acres for Option 3 vs 14.6 acres for Option 1. No other reasonable structural option exists. The nonstructural Option 2 would not satisfy the planning objective of providing a high level of flood protection or public safety to the region. Only 7% of the buildings in the Study Area are candidates for protection under this option. No protection would be afforded to transportation elements under Option 2. Floodgate Alignment 2 has been selected, in part, to minimize environmental impacts on wetland resource areas. Avoidance of the Lynn harbor impacts results in a significant reduction in necessary mitigation. Full compliance cannot be achieved since the structure itself would impact a footprint in the subtidal and intertidal areas.

re: (2) Impacts and mitigating measures are described, resource by resource, in Table 11.1.

re: (3) The public interest would be significantly served by the protection of 5,000 structures against tidal flooding, including all of those in Option 1 plus all major transportation arteries serving the Study Area and

Boston's north shore and local streets inside the floodgates and behind shorefront structures. The National interest would be served by protection of the GE Plant in Lynn. Truly a Regional Plan.

A Notice of Intent will be filed by the Project Proponents subsequent to approval of the Final EIR to further comply with the official documentation required by the Wetlands Protection Act.

Massachusetts Waterways Licensing Program (Chapter 91)

The Division of Wetlands and Waterways Regulation reviews and licenses activities to improve or modify waterways or sub-tidal lands including, but not limited to, dredging and wharf and pier construction. The standard of waterways projects proposed is to "minimize" adverse effects to the environment. As a matter of policy, the Division defers issuing a license until a permit under the Wetlands Protection Act has been written for the project; the conditions under that Order are generally included in the waterways permit to provide environmental protection standards. A variance procedure does exist but is used only in very rare or unusual cases.

The preferred Option 3 is consistent with the Chapter 91 Standards. An application for Chapter 91 License will be filed by the Project Proponents subsequent to approval of the Final EIR.

Area of Critical Environmental Concern (ACEC)

The Saugus/Pines Rivers Estuary is part of the recently (August 22, 1988) designated Rummey Marshes ACEC.

ACECs are those areas within the Commonwealth where unique clusters of natural and human resource values exist and which are worthy of a high level of concern and protection. The designation process comprises five steps: nomination, review by the Secretary, public hearings, decision by the Secretary, and publication of notice of the results in the Environmental Monitor. The purpose of the designation process is to determine if the nominated area is of regional, State, or national importance or contains significant ecological systems with critical interrelationships among a number of components. After designation, the aim is to preserve and restore these areas and all EOEAs are directed to take actions with this in mind.

ACECs subject all work within their boundaries to higher environmental performance standards under the various State programs such as CZM, Wetlands Protection Act and the Waterways Licensing Program. However, the Saugus River and Tributaries, Flood Damage Reduction Project has been exempted from the designation. The exemption, contained within the designation document, and signed by Secretary Hoyte, reads as follows:

"Two specific projects, and a few small activities accessory to other large public works projects falling outside the boundary, are to be exempted from the designation. These projects are being 'exempted' from the designation rather than 'excluded' from the boundary because they have a scope of activities which cannot be properly defined by a standard geographic

exclusion, are projects with potentially broad public benefits, and are or have already been closely scrutinized by the environmental regulatory agencies.

The Saugus River Flood Damage Reduction Project is the first project to be exempted from the designation. Like the excluded projects discussed above, this project will be exempted as it is approved by the Office of Coastal Zone Management through its Federal Consistency review. I feel that the ongoing interagency review process, directed by the Corps of Engineers, will allow the project to be closely scrutinized as to its environmental impacts and provide for appropriate mitigation. This process will meet or exceed the intent of the designation with regard to the proposed project."

12.0 Index, References and Appendices

<u>Study Document</u>			
<u>Subjects</u>	<u>EIS/EIR</u>	<u>Main Report (References Incorporated)</u>	<u>Appendices (References Incorporated)</u>
ACEC	Chapter 11B	P. 35-37	I
Affected Environment	Chapter 6		K
Air Quality	Para. 6.222-6.225 Para. 7.175-7.179		H
Alternatives	Chapter 5	P. 39-64	A
Areas of Concern	Para. 2.18-2.22		
Artificial Shorelines	Para. 6.94 - 6.100 Para. 7.62-7.68		K
Benthic Habitats	Para. 6.63-6.85 Para. 7.34-7.55		K
Bibliography	Chapter 13		
Business and Industrial Activity	Para. 6.187-6.192 Para. 7.131-7.133		H
Climate			K, B
Comparative Impacts of Alternatives	Para 5.84		
Correspondence			I
Cover Maps			K
Cover Sheet	Front Cover		
Employment	Para. 6.195 Para 7.134-7.136		H
Environmental Effects	Chapter 7		
Fish	Para. 6.101-6.117 Para. 7.69-7.95		K
Geology, Topography Soils and Seismicity			K, E
Groundwater			K
Historic & Archaeo- logical Resources	Para. 6.230-6.243 Para. 7.201-7.205		
Hydrology and Hydraulics	Para. 6.08-6.14 Para. 7.02-7.15	P. 24-26	K, B
Induced Development	Para. 7.122-7.128		H
Land Use	Para. 6.151-6.184 Para. 7.122-7.128		H, A
List of Preparers	Chapter 9		
Lobsters	Para. 6.117A-6.121 Para. 7.96-7.101		K
Major Conclusions and Findings	Para. 2.01-2.05		
Mass. Waterways Licensing Program	Chapter 11B		
Mass. Wetlands Protec- tion Act	Chapter 11B		
MEPA	Chapter 11B		

	<u>EIS/EIR</u>	<u>Main Report</u>	<u>Appendices</u>
Mitigation	Para. 5.23-5.59 Para. 5.67-5.83	P. 83-84	A, D
Mitigation Incremental Analysis			K, A
Navigation	Para. 6.205-6.207 Para. 7.148-7.162		
Need for and Objectives of Action	Chapter 4		
Noise	Para. 6.221 Para. 7.168-7.174		H
Other Conclusions and Findings	Para. 2.06-2.17		
Plankton			K
Planning Objectives	Para. 4.13		
Plans Considered in Detail	Para. 5.17-5.83	P. 67-110	A-H
Plans Eliminated from Further Study	Para. 5.01-5.04	P. 39-64	A
Population & Community Growth	Para. 6.196 Para. 7.137-7.138		H
Problems and Opportunities	Para. 4.10-4.12	P. 1-32	A
Project Economics - Damages and Benefits		P. 95-99	G
Project Plans, Profiles, Costs and Schedules			D
Property Values and Housing	Para. 6.185-6.186 Para. 7.129-7.130		H
Public Concerns	Para. 4.04-4.09		A, I
Public Facilities & Services	Para. 6.197 Para. 7.139-7.140		H
Public Involvement	Chapter 10	P. 33-37, 113	I
Public Involvement Program	Para. 10.01-10.17	P. 33-37, 113	I
Public Views and Responses	Para. 10.20-10.24	P. 107-108	I
Rare, Threatened and Endangered Species	Para. 6.148-6.149 Para. 7.119		K
Real Estate, Easements, Rights of Way			F
Recipients of Draft Study Report and EIS/EIR	Para. 10.19		
Recreation & Open Space	Para. 6.208-6.220 Para. 7.163-7.167		H
Relationship to Environmental Requirements	Chapter 11		
Required Coordination	Para. 10.18		
Sandy Beaches	Para. 6.86-6.93 Para. 7.56-7.61		K, D

	<u>EIS/EIR</u>	<u>Main Report</u>	<u>Appendices</u>
Sea Level Rise	Chapter 8	P. 14	A-C,G,H
Secondary & Cumulative Impacts	Para. 7.206		
Section 404(b)(1) Evaluation	After EIS/EIR		
Sedimentology			K,C,E
Significant Resources	Para. 6.04-6.07		
Social & Economic Factors	Para. 6.150		
	Para. 7.120-7.121		G,H
Study Authority	Para. 4.01	P.1	
Summary	Chapter 2		
Table of Contents	Chapter 3		
Transportation	Para. 6.198-6.204	P. 21-22	H
	Para. 7.141-7.147		
Unresolved Issues	Para. 2.23		
Visual Resources	Para. 6.226-6.229		
	Para. 7.180-7.200		
Water Quality	Para. 6.15-6.35		
	Para. 7.16-7.18		K,C
Wetlands	Para. 6.37-6.62		
	Para. 7.19-7.33		K
Wildlife	Para. 6.122-6.147		
	Para. 7.102-7.118		K
Without Conditions (No Action)	Para. 5.05-5.16	P. 27-30	A

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NEW ENGLAND DIVISION
U.S. ARMY CORPS OF ENGINEERS, WALTHAM, MA
SECTION 404(b)(1) EVALUATION

PROJECT: Saugus River and Tributaries, Flood Damage Reduction Study,
Lynn, Malden, Revere and Saugus, Massachusetts

PROJECT MANAGER: Mr. Robert G. Hunt Ext. (617) 647-8216

FORM COMPLETED BY: Mr. William A. Hubbard Ext. (617) 647-8518

PROJECT DESCRIPTION:

See detailed project description for the preferred Option 3 in Chapter 5 of the EIS/EIR. For Section 404 purposes, the following placement of fill would take place:

The Floodgate: 0.3 intertidal acres and 1.9 subtidal acres would be lost to (buried by) the concrete structure. (1 subtidal acre would be gained back from dredging.)

Lynn Harbor: 0.1 subtidal acres would be lost to steel sheet pile walls.

Point of Pines: 0.7 intertidal acres would be lost to (buried by) stone revetment along the shorefront between Carey Circle and Alden Ave. 2.7 acres along about 3000 feet of shorefront between Carey and the seawall at the north end of Point of Pines would be impacted by beach nourishment (17,000 cubic yards of sand placed within the intertidal zone - obtained from under the dunes between Alden Ave. and the seawall at the north end of Point of Pines). Also, sand, gravel and rock excavated at the toe of the stone revetment along the shorefront between Carey Circle and Alden Ave. would be placed as fill under the revetment.

1. Review of Compliance (Section 230.10(a)-(d)).

- a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose (if no, see section 2 and information gathered for EA alternatives;

YES X NO

- b. The activity does not appear to:
- 1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CNA;
 - 2) jeopardize the existence of Federally listed threatened and endangered species or their critical habitat; and
 - 3) violate requirements of any Federally designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies);

YES X NO

- c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see section 2);

YES X NO

- d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see section 5).

YES X NO

2. Technical Evaluation Factors (Subparts C-F).

	N/A	Not Signif- icant	Signif- icant*
a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C).			
1) Substrate.		X	
2) Suspended particulates/turbidity.		X	
3) Water.		X	
4) Current patterns and water circulation.		X	
5) Normal water fluctuations.		X	
6) Salinity gradients.		X	
b. Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D).			
1) Threatened and endangered species.	X		
2) Fish, crustaceans, mollusks and other aquatic organisms in the food web.		X	
3) Other wildlife.		X	
c. Potential Impacts on Special Aquatic Sites (Subpart E).			
1) Sanctuaries and refuges.	X		
2) Wetlands.		X	
3) Mud flats.		X	
4) Vegetated shallows.	X		
5) Coral reefs.	X		
6) Riffle and pool complexes.	X		
d. Potential Effects on Human Use Characteristics (Subpart F)			
1) Municipal and private water supplies.	X		
2) Recreational and Commercial fisheries.		X	
3) Water-related recreation.		X	
4) Aesthetics.		X	
5) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves.		X	

Remarks: Explanation of identified significant impacts:

3. Evaluation and Testing (Subpart G).

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

- 1) Physical characteristics.....X
- 2) Hydrography in relation to
known or anticipated
sources of contaminants.....X
- 3) Results from previous
testing of the material or
similar material in the
vicinity of the project.....X
- 4) Known, significant sources
of persistent pesticides
from land runoff or
percolation.....__
- 5) Spill records for petroleum
products or designated hazardous
substances (Section 311 of CNA).....__
- 6) Public records of significant
introduction of contaminants from
industries, municipalities, or other sources.....X
- 7) Known existence of substantial
material deposits of substances
which could be released in harmful
quantities to the aquatic environment
by man-induced discharge activities.....__
- 8) Other sources (specify).....__

List appropriate references.

The sandy nature of the material from under the dunes, to be used for beach nourishment, is based on a boring. The log is available at NED, Corps of Engineers, Waltham, MA

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to require constraints. The material meets the testing exclusion criteria.

YES X NO

4. Disposal Site Delineation (Section 230.11(f)).

a. The following factors, as appropriate, have been considered in evaluating the disposal site.

- 1) Depth of water at disposal site.....X
- 2) Current velocity, direction, and
variability at disposal site.....X
- 3) Degree of turbulence.....X
- 4) Water column stratification.....—
- 5) Discharge vessel speed and
direction.....—
- 6) Rate of discharge.....—
- 7) Dredged material characteristics
(constituents, amount, and type
of material, settling velocities).....—
- 8) Number of discharges per unit of
time.....—
- 9) Other factors affecting rates and
patterns of mixing (specify).....—

List appropriate references.

See EIS/EIR

b. An evaluation of the appropriate factors in
4a above indicates that the disposal site
and/or size of mixing zone are acceptable.....YES X NO

5. Actions To Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken,
through application of recommendation of Section
230.70-230.77 to ensure minimal adverse effects of
the proposed discharge.....YES X NO

List actions taken.

Compensation of habitat loss through habitat construction (see Chapter 5
of EIS/EIR - Option 3 Mitigation).

6. Factual Determination (Section 230.11).

A review of appropriate information as identified in items 2 - 5 above indicates that there is minimal potential for short or long term environmental effects of the proposed discharge as related to:

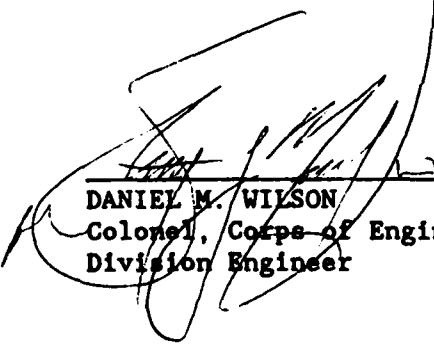
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|---|-------|----|
| a. Physical substrate
(review sections 2a, 3, 4, and 5 above). | YES X | NO |
| b. Water circulation, fluctuation and salinity
(review sections 2a, 3, 4, and 5). | YES X | NO |
| c. Suspended particulates/turbidity
(review sections 2a, 3, 4, and 5). | YES X | NO |
| d. Contaminant availability
(review sections 2a, 3, and 4). | YES X | NO |
| e. Aquatic ecosystem structure, function
and organisms (review sections 2b and
c, 3, and 5) | YES X | NO |
| f. Proposed disposal site
(review sections 2, 4, and 5). | YES X | NO |
| g. Cumulative effects on the aquatic
ecosystem. | YES X | NO |
| h. Secondary effects on the aquatic
ecosystem. | YES X | NO |

7. Findings of Compliance or non-compliance.

The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b) (1) guidelines.

14 DEC 87

DATE


DANIEL M. WILSON
Colonel, Corps of Engineers
Division Engineer